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ABSTRACT

The project, consisting of five experiments, attempted to develop remedial procedures and materials for retarded children with learning deficits in the area of arithmetic. Standardized training procedures were devised to facilitate development of operations (conservation, ordination, cardination, and classification) which J. Piaget describes as related to number readiness. Training procedures included manipulation of objects, introduction of conflict, individual programing, knowledge of results, and training to criterion. The experiments treated the following five topics respectively: the acquisition of conservation of quantity by educable mentally retarded children; the acquisition of conservation, ordination, cardination, and classification by educable retardates; the acquisition of quantity by institutionalized educable and trainable retardates; the effectiveness of conservation, ordination, cardination, and classification training procedures with educable and trainable retardates; and the use of group procedures in conservation, ordination, cardination, and classification training of educable retardates. Data were found to demonstrate that it is possible to accelerate cognitive development in retarded children by means of the above training procedures. Appendixes contain information on the required materials, the procedures and the instructions for various lessons devised in the experiments. (GW)

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FINAL REPORT

PROJECT No. 8-0054

GRANT No. OEG-0-8-080054-2694 (032)

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FACILITATION OF COGNITIVE DEVELOPMENT AMONG CHILDREN WITH LEARNING DEFICITS

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AUGUST 1971

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U.S. DEPARTMENT OF
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BUREAU OF RESEARCH

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Rosaria A. Bulgarella

Foundation For
California State College, San Bernardino

San Bernardino, California

August 1971

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INTRODUCTION

Problem

One of the most relevant theories for curriculum development has been proposed by Jean Piaget, a Swiss developmental psychologist, who has recently gained prominence in the United States. According to Piaget, all children advance through certain stages of intellectual development, in unchanging order, from lowest to highest. Piaget's stages of intellectual development are generally divided into four broad periods as follows:[1]

1. The period of sensory-motor intelligence (0-2 years). One of the most interesting, as well as important, occurrences during this pre-verbal period is the development of object permanence. That is, the infant at first acts as if objects no longer exist when they disappear from his sight, but later looks for them even when they are hidden from view. Moreover, along with the development of object permanence, the notions of sensory-motor space, time sequence, and sensory-motor causality also develop. During this period and its six major stages and substages, the child interacts with the environment and acquires a sensory-motor understanding of the world.

2. The period of pre-operational intelligence (2-7 years). During this period, the beginning of language and symbolic representation occur. That is, the child is able to use a symbol or sign to represent an object which may not be present. His thinking, however, is egocentric in that he sees things from only one point of view. There is, moreover, a lack of operations (interiorized actions, such as ordering, classifying, counting, measuring, adding, etc., on objects). Furthermore, the child exhibits an inability to mentally reverse an action and tends to center on only one quality of an object, thereby ignoring all other aspects. For example, when liquid in a particular container is poured into a different-shaped container, the child is incapable of mentally reversing the pouring action to its original state. In addition, he tends to center on only one quality such as height of liquid in the container, rather than both height and width. Consequently, there

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[1] Only a brief description is presented here. For more detailed descriptions see Flavell, 1963, or Furth, 1969.

is a lack of conservation (knowledge that quantity is invariant, no matter how one changes its shape perceptually, unless one adds or takes away some amount). According to Piaget (1952), conservation is important for all rational activity, including arithmetic thought. Therefore, it follows that until a child is able to conserve and perform operations such as ordering and classifying, it is futile to teach him mathematics.

3. The period of concrete operations (7-11 years). During this period, the child's conceptual organization of the world appears to take on its first real stability and order. Although his thought structure is still tied to the concrete world, it loses its egocentrism and is characterized by flexibility. The child is able to mentally reverse (go back to the beginning of an action) and decenter (pay attention to more than one quality simultaneously). Therefore, the child is able to conserve quantity. Moreover, he is able to perform operations such as ordering and classifying. Consequently, it is assumed that during this period, it would be fruitful to teach the child mathematics.

4. The period of formal operations (11 years and above). In this period, the adolescent's thought becomes more flexible. He now is able to deal not only with concrete problems of reasoning but also with hypothetical ones. The most important characteristic of this period is the ability to deal with possibility as well as with reality. In other words, he now shows reasoning on hypotheses, rather than merely on objects; the adolescent forms hypotheses which he can test by subsequent investigation in a systematic fashion.

Each individual, according to Piaget's theory, transverses through the above periods from birth to adulthood. The order of the periods does not change, although there are individual differences in rate of development. Moreover, not all individuals reach the later periods of development. The findings of Inhelder (1968) show that retardates go through the same order but they tend to fixate at a certain period, depending upon the extent of retardation. For example, the moderately retarded individual appears unable to go beyond preoperational thought, whereas, the mildly retarded one appears unable to progress beyond the period of concrete operations. This project will concentrate only on the periods of preoperational thought and concrete operations.

Piaget's theory is an ideal one to use for remedial purpose since an invariant order of stages in intellectual functioning is postulated for all individuals whether normal or not. This means that stage one must appear in every child before stage two can occur; stage two then can be said to be dependent upon the occurence of stage one. The fact that the stages are invariant in order means that one can compare the extent of the retardates' development in cognitive areas with that of normal children, thereby estimating the amount and nature of the deficit. Moreover, the invariant order of the stages also implies the course of remediation, i.e., guiding the child through the stages by means of training tasks specifically designed to develop the abilities characteristic of the next higher stage. For example, if a retarded child has fixated at the period of preoperational thought, it may be possible through training to enable the child to function at the level of concrete thought.

Although Piaget has not explained the reason for fixation at certain periods, he has been concerned with the mechanisms of transmission from one period to another (Piaget, 1964). He postulates these mechanisms to be maturation, experience, social transmission, and equilibrium. Maturation is defined as an interior change of the nervous system. Piaget distinguishes experience from social transmission by defining the former as the child's acquiring knowledge about the world through his actions upon physical objects and the latter as the child's receiving information through language or education. Piaget views the fourth factor, equilibrium, as the fundamental mechanism of transmission. Equilibrium may be thought of as active compensation which leads to a balance between assimilation (altering reality so that it will meaningfully fit into one's cognitive structure) and accommodation (modifying one's cognitive structures in order to fit reality). Berlyne (1960) has been able to explain equilibrium by means of internal reinforcements in learning. These reinforcements enable one to eliminate contradictions, incompatibiles, and conflicts.

As a consequence, the factors influencing transmission between periods appear to form an interaction between maturation and learning, and the last three factors may be subsumed under learning. Therefore, training should be of significant value if it encompasses the latter three factors--that is, interaction with objects, teaching or programming, and the inducement of conflicts whose resolutions are internally reinforcing. The present research project has attempted to incorporate these factors in an intervention program to facilitate number readiness in retardates.

Related Research

Since Piaget and his colleagues have written numerous books and articles about their work and many researchers have endeavored to replicate and extend their findings, it is possible to mention only a fraction of these studies.

It is now generally accepted that Piaget's description of invariant periods through which children progress is essentially valid. Numerous studies (see Flavell, 1963, p. 379-398 for a general summary and Sigel & Hooper, 1968, for selected articles on replication) have generally found that the order of the periods generally holds, although the ages may not be the same and some stages or substages may be reversed. Moreover, evidence from Woodward (1959), Lovell & Slater (1960), Stearns & Borkowski (1969), as well as Inhelder's (1968) extensive thesis mentioned previously, indicate that retardates also pass through the same periods as normal children, although they may not reach the higher levels.

Conservation has been emphasized in the present project since Piaget (1952), in his book on the child's conception of numbers, has assigned it a central role in all rational thinking, including arithmetic reasoning. Aside from any relationship to practical activity, however, the lack of conservation appeared to be a curious phenomenon and researchers have studied its parameters with relish (see Flavell, 1963, and Sigel & Hooper, 1968, for overviews; and among others, Goldschmid, 1967; Bittner & Shinedling, 1968; Halford, 1968, 1969; Hall & Kingsley, 1968; Saltz & Hamilton, 1968; Sawada & Nelson, 1968; Gottfried, 1969; Hooper, 1969; Murray & Johnson, 1969; Nummedal & Murray, 1969; Achenbach, 1969; Ford, 1970). Moreover, probably because of its implied practical application in education, researchers have attempted to accelerate conservation by a variety of training methods. The results of early studies were quite discouraging since they did not support the notion that training facilitates conservation (Wohlwill & Lowe, 1962; Smedslund, 1961a, 1961b, 1961c). The results of more recent studies (see Sigel & Hooper, 1968, for overview; Kingsley & Hall, 1967; Murray, 1968; Lumsden & Kling, 1969; Rothenberg & Orost, 1969; Halford & Fullerton, 1970; Overbeck & Schwartz, 1970; Peters, 1970; Strauss & Langer, 1970), on the other hand, have resulted in positive training effects leading to general acceptance of the view that the acceleration of conservation is possible.

The above studies have examined the concept of conservation in normal children. Perhaps stimulated by Inhelder's (1968, originally published in French, 1943) extension of Piaget's theoretical work to the area of mental retardation, researchers have also become interested in studying the retardate's proficiency on Piagetian-type tasks. A few studies (Achenbach, 1969; Keasey & Charles, 1967; McManis,

1969) compared retardates with normal Ss on conservation tasks. The findings generally showed that, like Inhelder's results, retardates exhibited a deficit on these tasks. Moreover, ability to conserve appeared to be related to mental age.

In spite of the educational value of accelerating cognitive development in retardates, few studies have been carried out using retardates instead of normal Ss. Brison and Bereiter (1967) trained retarded, normal, and gifted children to conserve quantity. Regardless of IQ differences, the three groups did not differ significantly in acquisition of conserving responses and transfer to new material. Although untrained controls were not used, the increase in scores for all groups indicated that training may be as beneficial to retardates as to normal and gifted children. Moreover, a study by Lister (1969) has indicated that it is possible to teach educationally subnormal children to conserve weight by means of an individualized, but standardized procedure, involving different tasks, manipulations, and explanations. A later study (Lister, 1970) reported success in using similar methods to teach educationally subnormal children to conserve volume.

Results from the above training studies with retardates, who may be classified as mildly retarded or educable, support the hypothesis that these children, as well as normal children, benefit from training programs to facilitate their intellectual functioning. In the long run, it may be more worthwhile to concentrate attention on the retardate's, rather than normal child's, acceleration.

Objectives

The main objective of this project was to develop remedial materials and procedures for children who are educationally handicapped, particularly children who are diagnosed as educable retardates. These materials and procedures were specifically devised to develop certain abilities described by Piaget as characteristic of more advanced cognitive reasoning in the area of arithmetic. That is, these materials and procedures were designed to advance the retardated child's mental development from the level of preoperational thought to concrete operations. As discussed above, the child is ready at the latter period to be taught a variety of subjects, such as arithmetic, whereas previously he was not.

The development of materials and procedures for remedial purposes involved a program of several steps. First, deficits must be assessed. It was decided to modify Piaget's testing procedures which he used in a clinical fashion so that they could be administered in a standardized procedure to retarded individuals. An attempt was made to keep testing materials and methods as similar as possible to Piaget's. Consequently, materials which were unavailable commercially were specifically constructed.

The next step involved development of training materials and procedures. It was decided to standardize these procedures so that the method of administration would be the same, no matter who administered it. Furthermore, certain features which were believed to be important to success were incorporated into the training procedures. These features were manipulation of objects, individual programming, knowledge of results, introduction of conflict, and training to criterion. That is, when feasible, the child was allowed to manipulate the materials, and the task was programmed so that a failure was followed by extra training to allow the child to correct his response. Moreover, by reversal of the transform to its original state, the child always received feedback about the correctness of his response. Reversal to the original state also served the function of inducing conflict when the child discovered that, although he had been certain of a particular response, the reversal showed him to be wrong. Finally, all Ss were run to a criterion of no errors in the series of transformations.

The third step consisted of experimenting with the new materials and procedures in a controlled situation to determine whether they were successful. This involved cooperation of the school system, principals, and teachers where the special education classes were located since all testing and training were carried out at the individual schools. Before their use in schools, however, the materials and procedures were generally tested in a pilot study on several young, but normal, children of colleagues.

A final aspect involved the evaluation of the training procedures through comparison with a control group's performance. The effectiveness of the training procedures was thus assessed, and, if it appeared feasible or beneficial, some changes were made. Finally, an attempt was made to assess the effects of these subsequent changes.

As stated previously, the main objective of this project was to develop remedial procedures and materials for children with learning deficits. As the project progressed, it was decided to limit the scope of the project to number readiness, or arithmetic, particularly since facilitation of number readiness is likely to have a pragmatic effect on curriculum planning. Consequently, a series of experiments were carried out to accelerate abilities which Piaget hypothesized related to a child's understanding of numbers.

These abilities were conservation, ordination, cardination, and classification. Conservation has been defined previously as the knowledge that a quantity remains the same, unless one adds or takes away some, no matter how much the perceptual shape is changed. For example, if a child conserves quantity, he readily knows that merely pouring a quantity from a tall thin container to a very wide low one or shaping clay from a ball to a pancake does not change the original amount. Since conservation was considered extremely important by Piaget, conservation training was emphasized. Ordination and cardination appear to be related both in practice and in Piaget's theory to the concept of numbers. Ordination is defined as arranging varying objects in a consistent series so that each is the next largest (or smallest) one. Cardination, as examined in this project, also includes ordination but emphasizes the number of units which make up the members of the series. Moreover, this project was also concerned with classification since Piaget regarded "number as seriated class" (Piaget, 1952, p. 161), that is numbers are ordered sets, i.e., n, n + 1, n + 2, n + 3, etc. Moreover, sets (classes) are composed of the addition of subsets, i.e., 5 = 3 + 2. The latter is referred to as the additive composition of classes and related training was given. The above abilities were selected from those discussed by Piaget since they appeared to be both important for number readiness and feasible for training.

In summary, the following experiments represent an attempt to develop remedial materials and procedures in the area of number readiness for retarded children. Since abilities such as conservation, ordination, cardination, and classification were believed instrumental to the understanding of numbers, materials and procedures were developed by which retardates were trained for acceleration of these particular abilities. The development of the testing and training tasks involved several steps discussed above. Experiments I through V describe the last two steps, using the developed materials and procedures with retardates at local schools and evaluating their effectiveness.

Experiment I

The Acquisition of Conservation of Quantity by Retarded Children

ABSTRACT. Fifty educable retarded children who were determined to be nonconservers by means of three conservation pretests--discontinuous quantity, correspondence, and continuous quantity--were randomly assigned to one of five treatment groups--discontinuous quantity training, correspondence training, continuous quantity training, control, and control language group. The four hypotheses were as follows: (a) it is possible to train retardates to conserve quantity, (b) training effects on one form of conservation transfer to other forms of conservation, (c) performance on conservation tests is related to MA, and (d) discontinuous quantity conservation appears before continuous quantity conservation. In general, the results of the posttests were consistent with the four hypotheses.

Conservation has received much attention from researchers in recent years mainly because of the importance assigned it by Piaget (1952) and his colleagues who believe that conservation is necessary for all rational activity, including arithmetic thought. In the last decade, researchers of a pragmatic bent have been increasingly concerned with intervention programs to accelerate conservation in children, particularly because of its educational implications in the area of arithmetic. At first, the results of intervention appeared negative or, at best, questionable (Wohlwill & Lowe, 1962; Smedslund, 1961a, 1961b, 1961c). More recently, however, a number of studies (Wallach & Sprott, 1964; Wallach, Wall, & Anderson, 1967; Gruen, 1965; Beilin, 1965; Sullivan, 1967; Engelman, 1967; Gelman, 1969; Rothenberg & Orost, 1969) have demonstrated that some types of training have an accelerating effect upon conservation. The training techniques, however, are varied since investigators have devised methods which are compatible with their beliefs about the mechanisms that influence conservation. Moreover, it is not unusual to find that a particular training method which appeared to accelerate conservation in one study failed to do so in another. Some researchers (Mermelstein & Meyer, 1969) failed to find that any previously successful method accelerates conservation. The situation is even more complicated as indicated by the results of Hall & Kingsley (1968) which suggest that experimenters are able to greatly influence Ss' responses on conservation tests. The latter found that even adults may fail to conserve or may show extinction of conservation responses in certain situations. It is now, however, generally accepted that acceleration of conservation concepts is possible. Piaget himself has admitted its possibility (Hall, 1970), although he has questioned its desirability.

The present study also represents an attempt to accelerate conservation, but, unlike the studies cited above, retardates, instead of normal children, participated as Ss. Inhelder (1968) found that retardates follow the same stages of development as normal children, but at a slower rate. Moreover, depending upon the degree of retardation, retardates appear to fixate at a particular level, failing to achieve a higher stage. In view of Inhelder's findings, it appears an intervention program would be of great practical value for the education of retardates. Brison & Bereiter (1967) examined the relationship between general intelligence level (gifted, normal, and retarded Ss) and conservation training. Few differences were found among groups, indicating that mildly retarded Ss may benefit as much as other Ss from training to accelerate conservation. Because of lack of controls, however, the full extent of training effects was not assessable.

The present study was designed to train retarded children to conserve discontinuous quantity, establish correspondence between units, and conserve continuous quantity. The method of training included manipulation of objects, individual programming, training to criterion, and knowledge of results. The hypotheses tested are (a) retardates can be trained to conserve quantity or number, (b) training on one form of conservation transfers to other forms of conservation, (c) ability to conserve is related to mental age (MA), and (d) conservation of discontinuous quantity appears before conservation of continuous quantity.

Method

Subjects

The Ss consisted of 51 educable retarded children from elementary and intermediate Type A classes in an urban setting. These children, 24 females and 27 males, were selected from a sample of 103 testable Ss (11 were nontestable) on the basis of performance on three Piagetian pretests--discontinuous quantity, correspondence, and continuous quantity conservation. Children were eliminated from further participation in the study if they were in stage three as described by Piaget (1952) on more than one of the three verbal pretests; 52 Ss were eliminated. The remaining 51 Ss were randomly assigned to one of five treatment groups, three training and two control.

The mean Stanford-Binet IQ (scores attainable for only

44 Ss) was 71.77 (SD = 7.86); the mean chronological age (CA) was 9.[illegible] (SD = 1.33); and the mean MA was 7.04 (SD = 1.34). The mean IQs of the five groups--discontinuous quantity training, correspondence training, continuous quantity training, control, and control language--were 73.77, 70.88, 72.00, 70.67, and 71.50 respectively.

Procedure

Table 1.1 shows the design of the study. All Ss received

Table 1.1

Design of study showing
the five groups and their treatment.

DQ	Corr	CQ	C	CL
Pretests:	Pretests:	Pretests:	Pretests:	Pretests:
nCQ DQ Corr CQ	nCQ DQ Corr CQ	nCQ DQ Corr CQ	nCQ DQ Corr CQ	nCQ DQ Corr CQ
Treatment:	Treatment:	Treatment:	Treatment:	Treatment:
DQ training	Corr training	CQ training	Play session with clay	Play session with clay using same language as in training
Immediate posttest:	Immediate posttest:	Immediate posttest:	Immediate posttest:	Immediate posttest:
DQ	Corr	CQ	DQ, Corr, or CQ randomly assigned	DQ, Corr, or CQ randomly assigned
Final posttest:	Final posttest:	Final posttest:	Final posttest:	Final posttest:
DQ Corr CQ	DQ Corr CQ	DQ Corr CQ	DQ Corr CQ	DQ Corr CQ

four Piagetian pretests, in addition to a vocabulary pretest, and were then randomly assigned to one of five treatment groups. After treatment was completed, all Ss were again given the same tests as posttests. Ss were tested and trained individually by E; an observer (O) recorded all responses and conserving reasons, if any, given. A standardized procedure was followed by the five Es who tested and trained Ss.

Pretests

Vocabulary pretest. A vocabulary pretest (see Appendix A) was administered first to establish that S understood the words, "same," "more," "less," and "as many as," used later on the pretests. The pretest asked Ss to respond to verbal commands, such as "pour out more (the same amount of) pop than (as) I have in my glass," or "put out more (the same number of) chips than (as) I have here in my row." Children not exhibiting knowledge of at least "same" and "more" were eliminated from participation in the study as part of the nontestable Ss.

Conservation pretests. All Ss who were successful on the vocabulary pretest were given one nonverbal and three verbal conservation pretests in the following order: nonverbal continuous quantity, discontinuous quantity, correspondence, and continuous quantity. The pretests were also tape recorded.

Nonverbal conservation of continuous quantity (nCQ) pretest. The nCQ pretest was identical to task one in the study by Mermelstein & Shulman (1967). Their task, the "Magic Experiment," using specially constructed apparatus, consisted of a stand holding two 1000 ml. jars, one visible to the child and the other hidden behind the stand. The hidden jar, placed on a higher level, was filled with colored water and connected to the visible one by a plastic hose. A valve was used to control the flow from the hidden jar to the visible one. S first established that there was an equal amount of colored water in two 150 ml. beakers. Then one of the 150 ml. beakers was left near the apparatus, and the water in the other beaker was poured in the visible 1000 ml. jar. E with his free hand surreptitiously opened the valve as he poured the water. Consequently, the 150 ml. beaker of water appeared to fill the 1000 ml. jar. Mermelstein & Shulman (1967) scored responses as either stage three or stage one. "Gestures of surprise, puzzlement, smiles, 'chee,' 'wow,' etc. were scored at stage 3. The absence of observable changes in behavior was scored at stage 1" (p. 44). In this study, however, to gain greater precision, S was also asked whether he noticed something funny. If S responded in the affirmative, E asked "What was funny?" An O, facing S, recorded all observable changes in expression and responses to the questions.

Conservation of discontinuous quantity (DQ) pretest. A more detailed version of this pretest has been included in Appendix C. *S* was given a choice of yellow or green wooden beads. *E* and *S* then placed beads into two equal 600 ml. glass beakers, one at a time, and *S* was asked if they both had the same number of beads. After equivalence was established, *S* was asked whether necklaces made from the beads would be the same length. A series of transformations were then made, i.e., *S*'s beads were poured into a 150 ml. beaker, a 150 x 75 mm. glass dish, divided into two 250 ml. beakers, and then four 150 ml. beakers. After each transformation, *S* was asked whether he had the same number of beads as *E* and whether necklaces made from their beads would be the same length. All questions were in the form of a forced choice of "same" or "more," and explanations were asked for each answer.

Correspondence (Corr) pretest. The Corr pretest (see Appendix D) consistently used the word, "number," similar to Wallach & Sprott (1964), although their test was of provoked, rather than spontaneous, correspondence. According to Piaget (1952, p. 65), the former includes materials which suggest correspondence since they are qualitatively complementary (e.g., beds and dolls, flowers and vases, eggs and egg-cups, etc.). The child is generally told to "put one A opposite (or into) B" or to "exchange one A for B." For spontaneous correspondence, on the other hand, *S* must find the correspondence by himself, i.e., *S* is merely asked to put out the same number of objects as in a model. The Corr pretest in this study involved spontaneous correspondence, but the training method involved provoked correspondence. The latter was used for training, since the materials appeared to produce correspondence more naturally and Piaget found the same stages in development for both.

S was given his choice in color of plastic chips. *E* constructed a series of models and asked *S* to "take the same number of chips from your pile and make the same thing I just did." After *S* was satisfied that he had the same number of chips, *E* spread out (transformed) the model and asked whether *S* still had the same number as *E*. All questions were asked in the form of a forced choice of "same" or "more," and *S* was asked to explain each answer. The models consisted of 11 chips as a random (unstructured) figure, two parallel rows of 6 chips each, and a rhombus of 12 chips, respectively. After *S* completed a model with chips, he was given small sticks, and the procedure was repeated with the same models, except *S* was asked to use the same number of sticks as there were chips in the model.

Conservation of continuous quantity (CQ) pretest. For a more detailed version of this test, see Appendix F. S was given his choice of a large white or yellow clay ball. E then took the other ball and asked S if they had the same amount of clay. After equivalence had been established, E transformed S's clay into a sausage, a pancake, divided it successively into two balls, three balls, four balls, and finally transformed the four balls into a sausage, a pancake, a cube, and a cup. After each transformation, S was asked whether E and S had the same amount. All questions again were in the form of a forced choice of "same" or "more," and explanations were asked for each answer.

Treatment

All Ss who were judged to be at stage three on no more than one of the above verbal conservation tasks were randomly assigned to one of five treatment groups. Three groups received training related to discontinuous quantity, correspondence, and continuous quantity conservation, while two groups served as controls. It should be noted, however, that the training materials differed from the testing materials. Each treatment session was approximately one-half hour long.

Table 1.2 shows the two cycles to which all training Ss were exposed in order that the task be individually programmed. All Ss were exposed to cycle one, but Ss received cycle two only if they failed a transformation in

Table 1.2

Training cycles for discontinuous quantity, correspondence, and continuous quantity training.

Cycle One	Cycle Two
Equivalence state	Equivalence state
Transformation of one quantity	Transformation of one quantity
Judgment by S	Judgment by S
	Subtraction from or addition to transform
Reversal to equivalence	Reversal to equivalence

cycle one. Cycle one consisted of (a) establishing equivalence between two quantities, (b) transforming one quantity perceptually in form, (c) having S make a judgment about the equivalence of the two quantities after transformation, and (d) checking by reversing the transform to its original form. The last step gave S feedback about the correctness of his response. If S gave an incorrect response on cycle one, moreover, cycle two was carried out. Steps a, b, and c were identical to those in cycle one. If S again maintained that the two quantities were unequal after transformation, he was asked to take away or add until he believed them equal. His response was then checked by reversing the transform to its original form. After reversal, S was shown that not only were the quantities no longer equal but they were unequal by the amount which he took away or added. The last cycle ensured that the amount of training given was dependent on S's performance. Moreover, cycle two allowed S to determine on his own that unless one added or took away, the quantities remained equal. Criterion was reached when cycle two was not needed for any transform, i.e., S made no errors. This training technique, because of the incorporation of cycle two, was believed to encourage the acquisition of conservation rather than a response set to say "same."

Discontinuous quantity (DQ) training group. Appendix K gives a detailed version of this procedure. Ss assigned to this group were individually given DQ training which consisted of two parts. For the first part, materials consisted of three dozen erasers and six boxes of varying dimensions. The erasers and two rectangular wooden boxes, identical in size and shape, were placed on a table, one before S and the other before E. The E instructed, "every time I put one eraser in my box, you put one in yours." This procedure was carried out until there were enough erasers in the boxes to cover the bottoms in a single layer. The two boxes had been deliberately constructed so that one layer of erasers fitted exactly from side to side.

After equivalence of the erasers had been established, the remaining four boxes of different shapes, all larger than the original ones, were successively presented. Training cycle one was carried out with each box individually, with S's erasers divided between two of the above varied boxes, and finally with S's erasers divided among the four boxes. If S failed to show conserving responses upon presentation of a particular box or combination of boxes, training cycle two was immediately carried out using the same box(es).

After completing the training cycles with each box and combination of boxes, a similar training procedure was used with rhythm sticks and six decorated tin cans of different sizes. The two smallest cans of equal size were used to establish equivalence. Exactly 12 sticks could fit into each can. After S said that both cans had the same number of sticks, E performed several transformations. Training cycle one, and if necessary, two were carried out with S's sticks successively in four larger cans, in two cans together, and finally in four cans together.

Training with erasers and boxes and then with sticks and cans was repeated for half-hour sessions until criterion was reached on both training tasks. S reached criterion when he was able to go through all transformations on a task without a single error. After S had reached criterion on both tasks, he was given an immediate posttest, identical to the DQ pretest.

Correspondence (Corr) training group. A detailed version is contained in Appendix L. Ss assigned to this group received individual training in provoked correspondence similar to that used by Wallach & Sprott (1964). Eight tiny cans (35 mm. film containers) were placed in a row on the table. E directed S to place a cap on each can; equivalence of caps and cans was then established. Next, E removed the caps and placed them before the cans but closer together so that at least one can was left without a cap in front of it. S was then asked about the equality of the number of caps and cans. Reversal (putting the caps back on the cans) was carried out to give S feedback about the correctness of his response.

The transformations (a) caps closer together and (b) caps farther apart were alternately repeated twice for each of four figures successively. Upon failure on a particular transformation, the transformation was repeated as cycle two in which if S failed to conserve again, he was asked to remove or add some cans or caps. Again S was asked to predict whether each can would have a cap if the caps were put back on each can, and the reversal was carried out to check S's response. It was then emphasized that the number by which the caps and cans were unequal was the same as the number that had been removed or added.

Each transformation was repeated until S reached criterion, i.e., cycle two training was not needed because S made no errors. The entire training procedure was carried out to criterion with the following figures: (a) single row, (b) open square, (c) closed square, and (d) square outside (caps formed into a square away from the square made by the cans). After S reached criterion on the last figure, an immediate posttest, identical to the Corr pretest, was given.

Continuous quantity (CQ) training group. A detailed version of this procedure is given in Appendix N. Ss assigned to this group received individual training on continuous quantity conservation with colored water and sand. Two 600 ml. glass beakers with equal amount of "pop" (colored water) were presented, one for E and one for S. Equivalence of the quantity of "pop" in the two beakers was first established. A succession of glass beakers and containers was presented to S in the following order: (a) one 150 x 75 mm. glass dish, (b) two 250 ml. beakers, (c) one 250 ml. beaker and two 150 ml. beakers, (d) four 150 ml. beakers, and (e) one 150 ml. beaker, one 250 ml. beaker, one 600 ml. beaker, and one 150 x 75 mm. glass dish.

A series of steps were followed with each set of beakers. First, S was asked to predict what would happen if the "pop" from his container were poured into the newly presented container(s). The transformation was carried out, and S was asked if the two quantities were equal. The S was then asked to predict what would happen if the operation were reversed, and the reversal was carried out to check whether S was correct.

The same transformation was carried out again if S failed. On this second presentation, or cycle two, if S maintained that the quantities were not the same, he was asked to take away the extra "pop" by pouring it into another jar. This was again followed by a reversal prediction and then by the actual reversal. Upon pouring the "pop" back into the 600 ml. beaker, S would find that the quantities were not equal. E then asked him to pour some "pop" back from the amount he had taken away until both 600 ml. beakers had the same amount of "pop" in them again. It was pointed out that the amount of "pop" taken away and the amount of "pop" S had to add were the same.

After going through the succession of containers, the entire procedure was repeated with sand instead of "pop." The S reached criterion when he was able to go through all transformations for both sand and "pop" without cycle two, i.e., without a single error. After criterion was reached, an immediate posttest, identical to the CQ pretest, was administered.

Control (C) group. Each control S was given two one-half hour sessions with E, since this was approximately the average time spent by Ss in the training groups (mean time = 50.33, 35.63, and 63.63 for the DQ, Corr, and CQ groups respectively). E and S started with two balls of clay, and S was asked what he would like to make. S was allowed to do whatever he wished with his clay; however, E helped S whenever he appeared to wish it or interest lagged. At the end of the last session, S was given an immediate posttest--DQ, Corr, or CQ, randomly assigned--in order to equate the number of test exposures for the training and control groups.

Control language (CL) group. The control language group, which was added in order to control for S's exposure to the terms, "more" and "same," used in training, also made objects of clay. Their procedure (see Appendix R), however, was more rigorous than the control group above, since an attempt was made to equate the number and types of questions with those of the training groups. These Ss also spent two one-half hour sessions, but E controlled the type of objects made and consistently asked questions, using the terms, "more" and "same," about the quantity of clay. Unlike the training sessions, there were no reversals, additions or subtractions of materials, or confirmations of S's response. In other words, only the language was similar to that of the training groups. At the end of the last session, S was given an immediate posttest--DQ, Corr, or CQ randomly assigned--in order to equate the number of test exposures for the control and training groups.

Conservation posttests. One week after the immediate posttest, the three verbal conservation pretests were again administered to each S in exactly the previous manner.

Results

Each of the 103 pretested children were scored by two independent judges for Piaget's three stages of development in conservation. The scoring ranged from one to five in order to facilitate scoring transition between stages. The Spearman rank correlations between judges were .97, .94, and .94 for the DQ, Corr, and CQ pretests respectively. Any S who was scored as four or five on more than one of the three verbal pretests was removed from further participation in the study. Fifty-one children of the 103 tested Ss participated in the study, but, because the school year terminated before training was completed, data from one child were deleted. Consequently, the results of this study are based on 50 Ss, except for MA, CA, and IQ data which were based on only 44 Ss. Table 1.3 shows the breakdown of number of Ss in each group who were nonconservers, partial conservers, and total conservers corresponding to Piaget's three stages.

Because each test had a different number of questions, the number correct was scored as the percentage of total possible correct for comparison purposes. Weighted means of the total pre- and posttest scores were obtained by weighting Ss' percentage correct for the three pre- and posttests. Figure 1.1 illustrates the performance of the five treatment groups on the verbal pre- and final posttests (DQ, Corr, CQ, and weighted mean of the three tests).

Table 1.3

Number of nonconservers,
partial conservers, and total conservers
in the five treatment groups on the three pretests.

Group	Test	Non-conservers	Partial conservers	Total conservers
	DQ	8	3	0
DQ	Corr	6	3	2
	CQ	11	0	0
	DQ	6	3	0
Corr	Corr	4	5	0
	CQ	9	0	0
	DQ	5	5	0
CQ	Corr	4	5	1
	CQ	7	2	1
	DQ	5	5	0
C	Corr	5	5	0
	CQ	10	0	0
CL	DQ	3	6	1
	Corr	8	1	1
	CQ	6	4	0

The data from the immediate posttest given upon reaching criterion were compared with those from the final posttest given one week later by means of the t test for related samples. No significant differences were found between the two posttests ($t = .47$, $df = 10$, $p > .05$ for the DQ posttest, $t = 2.38$, $df = 8$, $p > .05$ for the Corr posttest, and $t = .21$, $df = 9$, $p > .05$ for the CQ posttest).

The final posttest data were subjected to analyses of covariance with the pretest scores as the covariate. Since the scores were reported in percentages, an arcsin transformation of scores was made prior to analyses. Significant differences were found among the five groups on the DQ, Corr, and CQ conservation posttests and the weighted mean of all three conservation posttests ($F = 14.76$, $df = 4/44$, $p < .01$; $F = 4.37$, $df = 4/44$, $p < .01$; $F = 7.58$, $df = 4/44$, $p < .01$; and $F = 13.71$, $df = 4/44$, $p < .01$ respectively for the above measures).

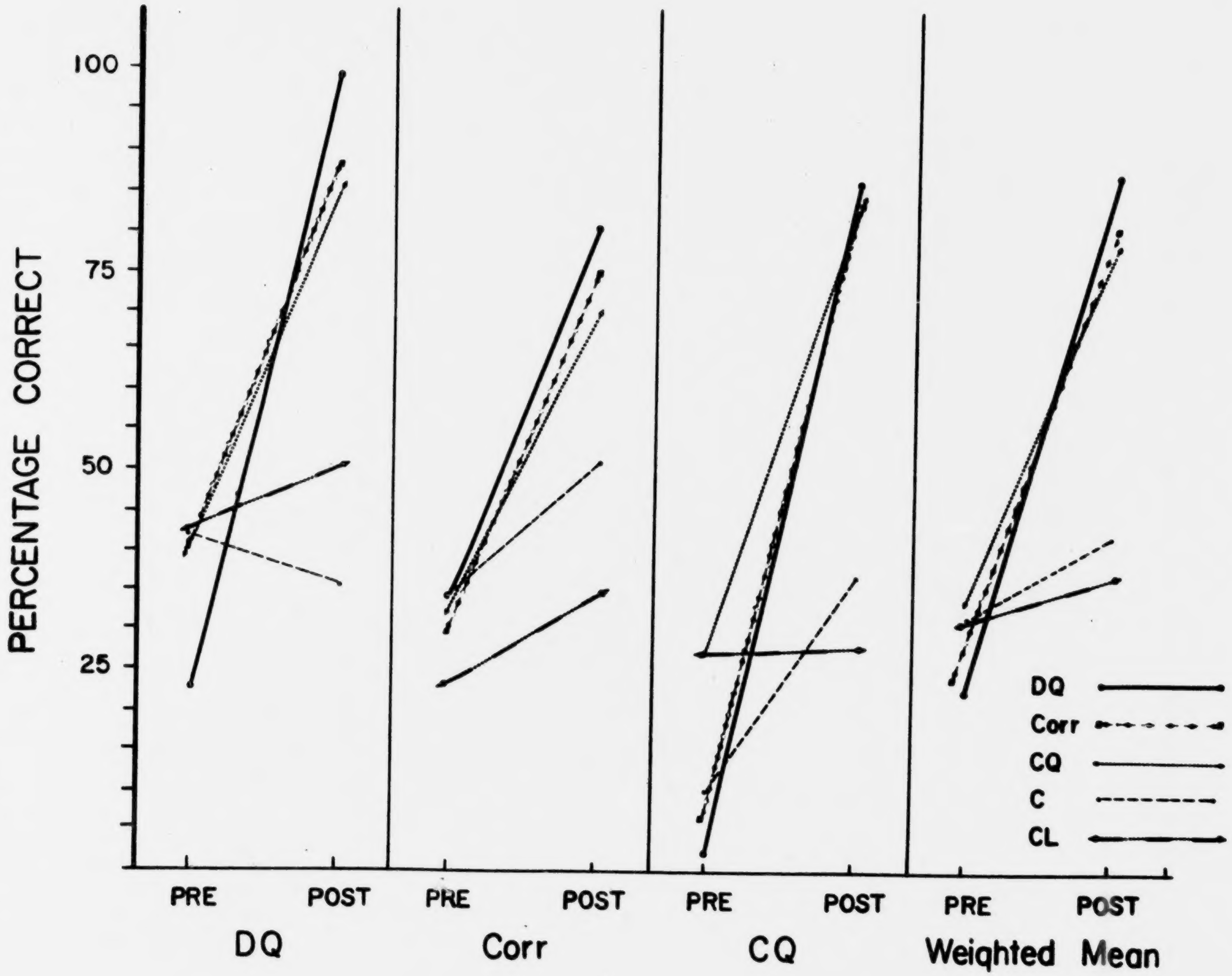

Figure 1.1 Performance of the three treatment groups on the DQ, Corr, and CQ pre- and posttests and the weighted means of the three pre- and posttests.

Multiple comparisons (Winer, 1962, p. 592) were made between the adjusted posttest means. Table 1.4 indicates the groups which differed significantly from each other. All training groups differed significantly from both control

Table 1.4

Multiple comparisons between the adjusted posttest means.

Post-tests	Groups	DQ	Corr	CQ	C	CL
DQ	DQ	-		*[1]	*	*
	Corr		-		*	*
	CQ			-	*	*
	C				-	
	CL					-
Corr	DQ	-			*	*
	Corr		-		*	*
	CQ			-		*
	C				-	
	CL					-
CQ	DQ	-			*	*
	Corr		-		*	*
	CQ			-	*	*
	C				-	
	CL					-
Weighted Mean of Posttests	DQ	-		*	*	*
	Corr		-		*	*
	CQ			-	*	*
	C				-	
	CL					-

[1] The asterick indicates that these groups differed significantly beyond the .05 level.

groups on the DQ posttest; moreover, the group receiving training on DQ was significantly superior to the group receiving CQ training. On the Corr posttest, the DQ and Corr training groups differed from the C and CL groups, but CQ training group differed only from the CL group. On the CQ posttest, all training groups differed from both control groups. Finally, on the weighted mean of the posttests, all training groups differed from the control groups and the DQ group differed from the CQ group. All other differences were nonsignificant.

Although Ss were generally nonverbal in the testing situation, the number of Ss giving at least one conserving response on the different tests was examined. Tables 1.5, 1.6, and 1.7 show the number of Ss giving conserving responses on the DQ, Corr, and CQ posttests respectively. The

Table 1.5

Distribution of trained and control Ss who gave conserving reasons on the DQ posttest.

	No conserving reason	At least one conserving reason	Total
Trained	7	23	30
Control	14	6	20
Total	21	29	50

Table 1.6

Distribution of trained and control Ss who gave conserving reasons on the Corr posttest.

	No conserving reason	At least one conserving reason	Total
Trained	8	22	30
Control	13	7	20
Total	21	29	50

Table 1.7

Distribution of trained and control Ss who gave conserving reasons on the CQ posttest.

	No conserving reason	At least one conserving reason	Total
Trained	12	18	30
Control	13	7	20
Total	25	25	50

chi-square test was used to examine whether approximately the same proportion of trained and control Ss gave conserving explanations for their answers. The trained and control Ss differed significantly on the DQ and Corr, although not CQ, posttests ($X^2 = 8.90$, df = 1, $p < .01$; $X^2 = 5.75$, df = 1, $p < .01$; and $X^2 = 2.08$, df = 1, $p > .05$ for the DQ, Corr, and CQ posttests respectively), showing that proportionately more trained Ss reported conserving reasons than did the control Ss on the DQ and Corr posttests.

The reliability of the three verbal tests was checked by examining the degree of relationship between the pre- and posttest scores for both control groups by means of the Pearson product-moment correlation. The correlation coefficients between pre- and posttests for the DQ, Corr, and CQ tests were .74, .80, and .51 respectively.

The relationships among the three tests were examined by means of the Pearson product-moment correlation of pretest scores. The correlation coefficient between DQ and Corr was .45, df = 48, $p < .01$, between Corr and CQ, .29, df = 48, $p < .05$, and between DQ and CQ, .18, df = 48, $p > .05$.

Moreover, the relationships between the pretests and individual differences such as CA, MA, and IQ were examined by means of the Pearson product-moment correlation. Table 1.8 shows the correlation coefficients between the three pretests and individual differences. Performance on DQ and Corr showed significant relationships with MA. Moreover, significant relationships were found between DQ and CA and between Corr and IQ. CQ, on the other hand, appeared unrelated to MA, CA, or IQ.

The relationships between general training effectiveness and individual differences for the trained Ss were also

Table 1.8

Relationships between measures of individual differences and pretest scores.

	DQ	Corr	CQ
MA	.39**	.44**	.11
IQ	.24	.41**	.08
CA	.34*	.27	.10

* $p < .05$, df = 42

** $p < .01$, df = 42

examined. The effectiveness of training was defined as the amount of improvement from pre- to posttest as the result of receiving either DQ, Corr, or CQ training. Table 1.9 shows the correlation coefficients between the improvement scores and MA, IQ, CA, and pretest scores. Amount of improvement on all tests was negatively related to the pretest scores. Moreover, improvement on the DQ test was negatively related to IQ and CA. No other relationships were found.

Table 1.9

Relationships between test improvement from pre- to posttest and individual differences for the trained Ss.

Test Improvement	Pretest Score	MA	IQ	CA
DQ	-.71**[1]	-.24	-.78**[2]	-.83**[2]
Corr	-.66**[1]	-.11	-.15	-.01
CQ	-.57**[1]	.26	.19	.20

[1] $p < .01$, df = 28

[2] $p < .01$, df = 23

An analysis of variance of repeated measures on the transformed data from the three verbal pretests was used to determine which was the easiest, or first occurring, of the three types of conservation. Means for all Ss on the DQ, Corr, and CQ pretests were .37, .31, and .15 respectively. The analysis of variance yielded significant results (F = 15.49, df = 2/98, $p < .01$). The Newman-Keuls test of multiple comparisons (.05 level) showed that both the DQ and Corr means differed significantly from the CQ mean, but not from each other.

The nonverbal pretest of conservation of continuous quantity was analyzed separately from the verbal pretests. For the nonverbal test, S was scored at stage three if he showed a change in behavior and also reported that he noticed something funny. All other responses were scored as stage one. Of 85 nonconservers and conservers who gave both behavioral and verbal responses on the CQ pretest, 19 gave inconsistent behavioral and verbal responses. Of these 19 Ss, 12 reported they noticed something funny but showed no observable change in behavior. The other 7 indicated a change in behavior (smiled, etc.) but reported that they had not noticed something funny.

Since the nonverbal and verbal pretests of conservation of continuous quantity are thought to measure the same concept, the relationship between these two pretests was examined by means of the phi coefficient. The chi-square test for independence and the phi coefficient were computed successively for these data. A significant relationship was not found between the two continuous quantity pretests (X^2 = 3.43, df = 1, $p > .05$, ϕ = .20). Of 90 Ss, for whom stages could be determined on both tests, 18 passed only the verbal continuous quantity pretest and 17 passed only the nonverbal pretest.

Because Mermelstein and Shulman (1967) found that the nonverbal continuous quantity test was easier than the verbal discontinuous quantity test, an attempt was made to determine whether one of these was easier in the present study. The data from all pretested Ss who were at stage three on only one of the two pretests, nCQ or DQ, were subjected to McNemar's test. No differences were found (X^2 = .13, df = 1, $p > .05$) between the number (14) of Ss who passed the nCQ pretest only and the number (17) who passed the DQ pretest only.

Discussion

In general, the first hypothesis that retardates can be taught to conserve quantity was supported. Multiple comparisons showed that the groups which received training were superior to the control groups on all posttests. Although all three training methods were effective, DQ training appeared to be the most facilitating. The DQ group was superior to both control groups on all three posttests. The DQ group was also superior to the CQ group on the DQ posttest, indicating the CQ training is not as facilitating for DQ conservation as are DQ or Corr training. CQ training, moreover, though effective in facilitating performance on the CQ posttest, appeared to be less effective in transfer to the Corr task. Considering the weighted mean of the posttests, the differences were the same as those on the DQ posttest. All training groups were significantly superior to the two control groups. Again, DQ training resulted in better performance on the weighted mean of the posttests than CQ training.

Moreover, the above findings appear to have resulted from acquisition of conservation rather than a response set to say, "same," since (see Tables 1.5, 1.6, and 1.7) significant differences were found in the proportion of trained and control Ss giving conserving reasons for their answers on the DQ and Corr posttest. Proportionately more trained, than control, Ss gave conserving reasons. The latter indicates that Ss who received training did not blindly say "same," but actually presented logical reasons, e.g., "We started with the same," "You didn't add or take away," etc., for their answers. The lack of significant differences in proportion giving conserving explanations on the CQ posttest is rather interesting. It is believed that the decrease in conserving reasons on CQ, from DQ and Corr, may have resulted from the retarded child's uncertainty in a situation in which no feedback was given. Since CQ was the last test given, generally S had already given conserving explanations on both the DQ and Corr tests, but E continued to ask him to explain each answer. The child may have assumed E wished him to respond differently. Consequently, he became less verbal as testing continued. At any rate, it is unlikely that after giving conserving reasons on the first two tests, S suddenly developed a response set to say "same" only on the last test.

Furthermore, cycle two of the training task is believed to be highly instrumental in leading to conservation rather than response set. Cycle two was presented only upon S's failure to conserve after a particular transformation. In this cycle, the S who maintained that the quantities were unequal was asked to make them the same by adding or subtracting some amount. After reversal, S discovered that adding or taking away some amount now made the quantities unequal by that particular amount. It is believed that because S himself had to verify the correctness of his response, the nature of the training task was more conducive to learning conservation rather than a response set. Moreover, because the amount of training was dependent upon individual need and Ss were run to criterion, training procedures tended to be highly successful.

In addition, it must be noted that unlike many past studies, the materials used for testing and training always differed in the present study. It is unlikely that if a superficial response set to say "same" had been learned with a particular material, the S would still continue to use the same response with different materials at least one week later on the final posttest. Moreover, one must remember that the Ss were trained on only one type of conservation with specific materials. Yet, at least one week later, trained Ss responded correctly for the other two types of conservation, e.g., Ss trained on DQ using sticks and cans and boxes and erasers responded correctly a week later on the CQ posttest using clay.

Of great interest, moreover, are the comparisons between the immediate and final posttests. The lack of significant differences indicates that the results of training were stable over at least a one-week period. Other studies (Goldschmid, 1968; Wallach & Sprott, 1964; Kohnstamm, 1963; Gelman, 1969) have obtained training effects lasting as long as three weeks. Moreover, Rothenberg & Orost (1969) found training effects lasting over three months, indicating that these effects may be stable over long periods of time.

The second hypothesis that training on one type of conservation transfers to other types of conservation was also supported. As noted above and in Table 1.4, all training methods showed some transfer to the other types of conservation. Each group which had been trained only on one particular type of conservation was significantly superior to the control groups on the other types of conservation. The group trained on CQ, however, appeared to show the least amount of transfer.

When the coefficient of stability of the three verbal tests was examined by comparing the two control groups' pre- and posttest scores, the DQ and Corr tests showed a fairly high degree of reliability (r = .74 and .80 respectively). On the other hand, the CQ test showed only a moderate degree of reliability (r = .51). It must be noted, however, that most Ss were at stage one on the CQ test, and the range of scores was more limited than on the DQ or Corr tests. Moreover, a relationship was found between performance on the DQ and Corr pretests, but not between performance on the DQ and CQ pretests. Also a relationship was found between performance on the Corr and CQ pretests. It appears that the tests may measure several abilities, some of which may be common only to the DQ and Corr tests and others which may be common only to the Corr and CQ tests.

The finding of no relationships or significant negative relationships between general training effectiveness and individual differences (see Table 1.9) contrasts with results obtained in other studies (Beilin, 1965; Lumsden & Kling, 1969; Overbeck & Schwartz, 1970; Strauss & Langer, 1970). The latter researchers found that partial (transitional) conservers or older Ss benefited more from training than nonconservers or younger Ss. In the present study, it appears as if training was maximally effective for all Ss. This is not surprising since the training procedures were individually programmed and all Ss were run to criterion. Consequently, even the slowest performing Ss had a chance to learn up to the same level as the fastest Ss. Since negative correlations were found between pretest score and general training effectiveness, it appears that the individualized training program had generally effected optimal learning for all Ss, rather than just the brighter or more advanced ones.

The third hypothesis that ability to conserve was related to MA was upheld by the significant correlations between MA and the DQ and Corr pretest scores. Investigators, such as Kooistra (1963), Goldschmid (1967), and Achenbach (1969), have obtained similar results. In the present study, however, a relationship was not found between MA and the CQ pretest. Again, it must be noted that range of scores on the CQ pretest was more limited than the DQ and Corr scores. Kooistra (1963) also found a relationship between CA and conservation. In the present study, a relationship between CA and the DQ pretest only was found.

The fourth hypothesis that conservation of discontinuous quantity appears before continuous quantity was supported by the results of the analysis of variance for repeated measures. The DQ and Corr pretests were approximately the same in difficulty or order of development, whereas CQ was more difficult or appears later in development. The finding that DQ performance is higher than CQ performance is similar to the results of Elkind (1961) who used water and Kooistra (1963) who used clay. The results of Goldschmid (1967), on the other hand, suggest that CQ conservation (whether clay or water) may be easier than DQ conservation; CQ (mass) conservation using clay appeared to be easier than CQ using water. The situation, however, is complicated since Bittner and S hinedling (1968) found that water conservation tasks were easier than clay ones.

The results of the nonverbal test of continuous quantity conservation indicated that merely observing S for a change in expression may not be an adequate method of measuring conservation as was previously thought (Mermelstein & Shulman, 1967). The nonverbal and verbal CQ pretests appeared to be equal in difficulty, but a relationship was not found between these pretests. Moreover, unlike the results of Mermelstein and Shulman (1967), the nonverbal CQ pretest was not easier than the DQ pretest. In the present study, the nCQ and DQ pretests appeared to be approximately equal in difficulty.

In conclusion, the results indicate that it is possible to train retardates to conserve quantity and that training on a particular type of conservation facilitates performance on other types of conservation. Moreover, performance on the DQ and Corr pretests appeared to be related to MA, although performance on CQ did not. Finally, DQ and Corr conservation appeared easier than CQ conservation. The results of the present study, particularly because of its retarded sample, indicate that the case for training effects is not as pessimistic as some investigators (Kohlberg, 1968; Mermelstein & Meyer , 1969) have presented it. Specific training appears to have general facilitating effects which may be stable over time.

Experiment II

The Acquisition of Conservation, Ordination, Cardination, and Classification by Retarded Children

ABSTRACT. Seventy-one educable retarded children were assigned to three levels on the basis of their performance on Piagetian conservation, ordination, cardination, and classification pretests. Experimental Ss at level three were given training on conservation, ordination, cardination, and classification. Experimental Ss at level two were given training on ordination, cardination, and classification. Experimental Ss at level one were given classification training only. The hypotheses are: (a) conservation can be accelerated in retardates, (b) ordination and cardination can be accelerated in retardates, (c) classification can be accelerated in retardates, (d) conservation, ordination, cardination, and classification are related to mental age, and (e) training on conservation, ordination, and classification affects arithmetic ability. Comparison of the experimental and control group performance at level three supports the first three hypotheses, although the effectiveness of cardination training may be questioned as indicated by results at level two. Comparisons between levels indicated that conservation, ordination, and classification training procedures were highly facilitating. Moreover, conservation, ordination, and cardination operations were related to mental and chronological age; classification was not. Finally, evidence that training affected arithmetic ability as measured by a standardized achievement test was inconclusive.

According to Piaget (1952), the child's development of the concept of number is closely related to the development of conservation, ordination, cardination, and classification. Piaget and his colleagues have described the development of conservation, ordination, cardination, and classification in roughly three stages which correspond to his description of the middle periods--preoperational thought, a transitional phase, and concrete operations--in intellectual development. A number of studies having some success in accelerating conservation development from lower to higher stages have been reported (Wallach & Sprott, 1964; Wallach, Wall, & Anderson, 1967; Gruen, 1965; Beilin, 1965; Sullivan, 1967; Engelman, 1967; Gelman, 1969; Rothenberg & Orost, 1969; and Experiment I above.) Few studies, however, have been concerned with the acceleration of ordination, cardination, or classification operations. Sigel, Roeper, and Hooper (1966) used a training method involving classification, but they were concerned only with the effect of such training on conservation; no attempt was made to determine its effect on the operation of classification. On the other hand, Morf (1959) and Kohnstamm (1967), have specifically attempted to accelerate classification. Of the two, the latter has appeared more successful, although the lack of controls precludes any definite conclusions. Moreover, a recent study (Ahr & Youniss, 1970) has reported success in facilitating classificatory behavior through a correction training procedure.

The purpose of this study was to attempt to accelerate conservation, ordination, cardination, and classification operations in mentally retarded children who exhibit deficits in cognitive functioning (Inhelder, 1968). Since retardates generally experience problems in arithmetic reasoning, as well as other areas, training in these operations which Piaget believes related to understanding of numbers should be of educational value. The specific hypotheses are: (a) conservation can be accelerated in retardates, (b) ordination and cardination can be accelerated in retardates, (c) classification can be accelerated in retardates, (d) conservation, ordination, cardination, and classification are related to mental age (MA), and (e) training on conservation, ordination, and classification affects arithmetic understanding.

Method

Subjects

The Ss consisted of 71 retarded children (31 females and 40 males) from elementary and intermediate Type A classes in five urban and rural schools. They were selected from a total sample of 95 Ss on the basis of performance on six Piagetian tests--discontinuous quantity (DQ) conservation, correspondence (Corr), continuous quantity (CQ) conservation, ordination (O), cardination (C), and additive composition of classes (ACC).

Twenty-four Ss from the total sample of 95 did not complete the study; 13 failed the vocabulary pretest, 3 were nontestable, 6 moved during the study, 1 was absent most of the time, and 1 passed all six Piagetian pretests. The latter S was eliminated from further participation in the study. The other Ss' moving and absences led to loss of their data during the course of the study. Ss were divided into three levels on the basis of ability on the pretests and within each level were randomly assigned to experimental (training) or control conditions.

The mean of the Stanford-Binet IQ scores for 69 Ss (other S's scores were unavailable) was 74.75 (SD = 7.32). The mean of their mental age (MA) was 8.05 (SD = 1.33), and the mean chronological age (CA) was 10.81 (SD = 1.73). The mean IQ for the control (N = 35) and experimental (N = 36) group was 73.34 and 76.21 which did not differ significantly ($t = .156$, $p > .05$).

Procedure

Table 2.1 shows the design of the study. All Ss received a vocabulary pretest followed by six Piagetian tests. On the basis of judged stages on the pretests, Ss were placed into three levels. The stages based on Piaget's

Table 2.1

Design of the study showing the three levels and their different treatments.

Level 1	Level 2	Level 3
Pretests:	Pretests:	Pretests:
DQ Corr CQ O C ACC	DQ Corr CQ O C ACC	DQ Corr CQ O C ACC
Treatment:	Treatment:	Treatment:
ACC training (n = 6) vs. control (n = 8)	O, C, and ACC training (n = 12) vs. contol (n = 8)	DQ, Corr, O, C, and ACC training (n = 18) vs. control (n = 14)
Immediate posttests:	Immediate posttests:	Immediate posttests:
ACC	O C ACC	DQ Corr DQ O C ACC
Final posttests:	Final posttests:	Final posttests:
DQ Corr CQ O C ACC	DQ Corr CQ O C ACC	DQ Corr CQ O C ACC

criteria were determined for the DQ, Corr, and CQ pretests as follows: Stage one was complete failure by *S* to give any conserving responses to questions asked after each transformation performed on the experimental materials. Stage two was characterized by conflict where *S* was inconsistent, sometimes conserving and sometimes not. Stage three was characterized by consistent conservation after all transformations.

For the O and C pretests, stage one consisted of inability to construct an ordered series. Stage two was described by the ability to construct an ordered series after trial and error and inconsistent response to questions about the series, particularly those in which the materials were put into random order. Stage three consisted of quick and confident construction of the series and correct responses to all questions.

For the ACC pretest, stage one was characterized by complete failure to respond correctly to classification questions. Stage two was characterized by inconsistent responding, whereas stage three was described by correct responses to all classification questions.

Level three. All *S*s who were at stage one or two on all six pretests were assigned to level three. These *S*s were randomly divided into a control and experimental condition. The latter group was given training related to discontinuous quantity conservation, correspondence, ordination, cardination, and additive composition of classes. No continuous quantity conservation training was given since Experiment I indicated that discontinuous quantity training had a highly facilitating effect on continuous quantity conservation. The control *S*s received play sessions with clay equal to the average number of one-half hour training sessions the experimental *S*s needed for criterion on all five of the above training tasks successively. The mean number of sessions for DQ, Corr, O, C, and ACC training was 1.66, 1.52, 1.52, 1.86, and 1.53 respectively.

Level two. *S*s who showed high performance on DQ, Corr, and CQ but were at stage one or two on either O or C and ACC were placed at level two. These *S*s were also randomly assigned to a control or experimental group. *S*s in the latter group were given training relating to ordination, cardination, and additive composition of classes. All experimental *S*s in level two received both ordination and cardination training since it was believed that these are related (Piaget, 1952, p. 122). Control *S*s received play sessions with clay equal to the average number of training sessions the experimental *S*s needed to reach criterion on the three training tasks successively. The mean number of one-half hour sessions needed for criterion on O, C, and ACC training was 1.33, 1.46, and 1.00 respectively.

Level one. Finally, Ss who were found to be at stages one or two on the ACC pretest only comprised level one. These Ss were randomly assigned to a control or experimental group. The latter was given training related to additive composition of classes. Control Ss received play sessions with clay equal to the average number of sessions the experimental Ss needed to reach criterion on the ACC training task. The mean number of one-half hour sessions needed for criterion on ACC training was 1.08.

The assignment of Ss to the above levels appeared quite natural since the order of difficulty of the pretests, from easiest to most difficult, was found to be DQ, Corr, CQ, C, O, and ACC. An immediate posttest, identical to the pretests, was given after each experimental S reached criterion on a particular task. To control for number of exposures to tests, control Ss received the same immediate posttests as their experimental counterparts within the same level. Final posttests, also identical to the pretests, were given to all Ss. All of the above sessions were individualized; an observer (O) recorded all responses. Five Es interchanged the roles of E and O, using standardized procedures for both testing and training.

Pretests

The pretests were administered in two one-half hour sessions. The vocabulary pretest and the DQ, Corr, and CQ conservation pretests were given in the first session; the O, C, and ACC pretests were given in the second session. The order of the pretests below was the same for all Ss.

Vocabulary pretest. A vocabulary pretest (see Appendix B) was administered before the six Piagetian pretests to establish that S understood the meaning of words used on the pretests. These words included "same," "more," "smallest," "next smallest," "biggest," "next biggest," "shortest," "next shortest," "tallest," "next tallest," "in front of," "in back of," "between," "first," "last," "second," "third," "seventh," "ninth," and "tenth." Understanding of these words was tested by asking S to point to materials illustrating the meaning of the word. Ss not exhibiting knowledge of these terms were eliminated from participation in the study; 13 Ss were discarded for this reason.

Discontinuous quantity (DQ) conservation pretest. This pretest was identical to the one given in Experiment I. A detailed version is included in Appendix C. E gave S his choice in color of wooden beads. E and S each then placed an equal number of beads into two 600 ml. glass beakers, one at a time, and E asked if both had the same number of, or if one had more, beads in their beakers. After equivalence was established, E asked whether necklaces made from the beads would be the same length or if one would be longer. Following this, a series of transformations were made, i.e., E poured S's beads into a 150 ml. beaker, into a 150 x 75 mm. glass dish, divided them between two 250 ml. beakers, and then among four 150 ml. beakers. After each transformation, E asked S whether he had the same number of beads as E and whether necklaces made from their beads would be the same length. All questions were in the form of a forced-choice of "same" or "more/longer," and reasons were asked for each answer.

Correspondence (Corr) pretest. Although some changes were made, the Corr pretest was similar to that used in Experiment I. A detailed version of this pretest is included in Appendix E. E gave S his choice in color of plastic chips. E then constructed a series of models and asked S to "take the same number of chips from your pile and make the same thing I just did." After S was satisfied that he had the same number of chips, E spread out (transformed) his model and asked if they still had the same number or if one had more. Moreover, E asked S to explain each answer. The models consisted of a cross of 9 chips, two parallel rows of 7 chips each, and a rhombus of 12 chips respectively. After S completed each model with chips, he was given small sticks, and the procedure was repeated with the same model.

Continuous quantity (CQ) conservation pretest. The CQ pretest is identical to the one used in Experiment I; a detailed version is found in Appendix F. E gave S his choice of two different colored clay balls. E then took the other ball and asked S if they had the same amount or if one had more. After equivalence had been established, E successively transformed one ball of clay into a sausage, a pancake, two balls, three balls, four balls, and finally into a cup, a sausage, a pancake, and a cube. After each transformation, E again asked if they had the same amount or if one had more. Moreover, S was asked to give reasons for each of his answers.

Ordination (O) pretest. A more detailed version of the O pretest is included in Appendix G. The concept of a stairway and steps in it was carefully explained. E then gave S eight sticks varying in height and asked him to construct a stairway. Next, E presented seven more sticks of varying heights which fit in the stairway and told S that these steps had been forgotten and must be put between the others to make a bigger stairway. After S finished, his errors were quickly corrected, and E constructed another stairway with narrower sticks above S's stairway. Next, E, pointing to various steps successively on E's stairway, stated, "If I climbed up this many steps on my stairway, point to the step you would be on if you climbed the same number of steps in your stairway." This procedure was repeated with *E*'s stairway reversed and with *S*'s stairway in random order.

Cardination (C) pretest. For a more detailed copy of the C pretest, see Appendix H. *E* presented *S* with ten blocks from 1 x 1 to 1 x 1 x 10 inches and asked *S* to make a stairway. It was pointed out that the blocks were special so that the second block could be cut into two blocks like the first, the third block could be cut into three blocks like the first, and so on. *E* asked *S* how many blocks like the first one could be made from the fifth, seventh, and tenth blocks successively. Next, *E* pointed one at a time to two other blocks and asked *S* how many blocks like the first could be made out of each. Finally, the blocks were put in random order, and *E* successively pointed to five different blocks and asked *S* how many blocks like the first could be made out of them.

Additive composition of classes (ACC) pretest. A detailed copy of the ACC pretest is included in Appendix I. *E* presented *S* with three red and seven blue cloth (felt) squares and asked if all of the colored squares were made of cloth. After *S* answered in the affirmative, *E* asked if there were more blue or more cloth squares and whether a row of the blue squares or one of the cloth squares would be longer. Next, twelve extra red squares were added, and *E* asked whether there were now more cloth or more blue squares. Moreover, *E* asked if there were more cloth squares or more red squares. The twelve red squares were removed, and a can was placed before *S*. *E* asked whether there would be any squares left outside the can if all the cloth squares were placed in the can. *E* also asked whether there would be any squares left outside if all the blue squares were put inside the can. Finally, *E* again asked if all the squares were made of cloth and repeated the first two questions.

Treatment

The *S*s were assigned to the three levels on basis of performance on the six pretests. Within each level, *S*s were randomly assigned to an experimental or control condition. Control *S*s received play sessions with clay. Depending on their level, experimental *S*s received training on discontinuous quantity, correspondence, ordination, cardination, and additive composition of classes following a standardized procedure. Each treatment session was approximately one-half hour long.

Discontinuous quantity (DQ) conservation training. The training procedure was identical to that used in Experiment I (see Appendix K for the complete version). There were two separate training tasks. For the first task, the materials consisted of three dozen rectangular erasers and six rectangular boxes of varying dimensions. E first presented two small boxes, identical in size and shape with the instructions, "Every time I put an eraser in my box, you put one in yours." This operation was carried out until erasers covered the bottoms in a single layer. The two boxes had been constructed so that ten erasers exactly covered the bottom. After equivalence of number of erasers had been established, four boxes of different measurements, all larger than the original, were presented in succession. The following steps (see Table 1.2 in Experiment I), training cycle one, were carried out with each box individually, with S's erasers divided between two of the varied boxes, with S's erasers divided among the four boxes, and finally with two erasers added to S's erasers after transformation for training on a nonequivalent transform: (a) Equivalence of erasers was established in the two equal boxes; (b) The transformation was carried out by pouring S's erasers in the larger box(es); (c) S was asked whether E and S had the same number of erasers after the transformation; and (d) The transformation was then reversed (S's erasers were returned one at a time to the original box).

If S failed to exhibit conserving responses in cycle one, training cycle two was immediately carried out with the same box(es). The first three steps of cycle two were identical to those in cycle one (a, b, and c). If S again stated he had more erasers after the transformation, he was asked to remove the extra ones, counting each removed eraser; if he said he had fewer erasers, he was asked to add erasers, keeping count of the added ones, until he felt the amounts were equivalent. The transformation was then reversed. If S had taken away some erasers, the remaining erasers would not have covered the bottom of the box. It was then shown that the number of erasers S had taken away and the number needed to cover the bottom were the same. On the other hand, if S had added erasers, there would have been more erasers than needed to cover the bottom. It was then pointed out that the number of extra erasers and the number S had added were the same.

The second training task consisted of rhythm sticks and six decorated cans of various sizes. The two smallest cans of equal size were used to establish equivalence; exactly 12 sticks fitted into each of these cans. After S had established equivalence of the number of sticks, E performed the various transformations by transferring S's sticks into the larger cans. The same training cycles used with erasers and boxes were carried out with S's sticks in each successive can, divided between two cans, divided among four cans, and finally with two sticks added to S's sticks after transformation to serve for training on a nonequivalent transform.

Training with erasers and boxes and sticks and cans was alternated in half-hour training sessions until criterion was reached on both. S reached criterion when he completed all transformations successively without error. Following criterion, S was given an immediate posttest identical to the DQ pretest. Only the experimental Ss in level three received DQ training, although both experimental and control Ss in level three received the DQ immediate posttest to equate for number of test exposures.

Correspondence (Corr) training. This procedure (see Appendix M) was designed to encourage S to determine whether he had the same number of objects as E had in a model, rather than training for conservation, since Ss had already received DQ training. The materials consisted of tiny cans (35 mm. film containers) and their caps. E put out a number of cans as a model and asked S how many cans there were. After S had counted the number of cans, E asked S to take out the same number of caps and make the same thing as E had. When S had finished, E asked if there were the same number of caps as cans, and S's response was checked by putting the caps on the cans. This procedure was followed with 14 different models until S reached criterion. S reached criterion when he was able to take out the correct number for all 14 models successively. An immediate posttest, identical to the Corr pretest, was given after S reached criterion. Although only the experimental Ss in level three received Corr training, the control, as well as experimental, Ss received the Corr immediate posttest to equate number of test exposures.

Ordination (O) training. The materials (see Appendix O) consisted of one-eyed wooden "people" of varied heights called Zerbils and their homes (wooden doors of corresponding heights). E told S that Zerbils always walked in a straight line from smallest to tallest so that they could see over the head of the Zerbil in front in case of danger. E then asked S to order the Zerbils from smallest to tallest so that each Zerbil could see over the head of the one in front. Next, E presented the doors with instructions that the Zerbils lived in invisible houses with visible doors and asked S to place the doors from smallest to tallest like the Zerbils so that each Zerbil could easily find his house. Finally, after reversing the order of one series, as well as putting the Zerbils in random order, E asked S to find the homes belonging to selected Zerbils.

The training procedure was individually programmed so that if S failed, he was immediately given an extra training loop which allowed him to correct his error. Criterion was reached when S was able to carry out all the above operations without any errors. An immediate posttest identical to the

O pretest was given after S reached criterion. Experimental Ss in levels three and two received O training. Control Ss in the same levels were given the O immediate posttest.

Cardination (C) training. There were two parts to this procedure (see Appendix P). In the first part, E presented 15 blocks, each of a cubic inch, and asked S to make a stairway with the first step having one block and the last having five blocks. E then asked how many more blocks some steps had than others and how many blocks needed to be added or taken away to make two steps the same in height.

For the second part, E presented six strips of felt from 1 x 1 to 1 x 6 inches and asked S to make a stairway. E then asked how many pieces like the first step in the stairway could be made out of the other steps. Each response was checked by placing extra 1-inch squares of a different color on the strip in question. Following this, E presented several strips of felt, 1 x 3 inches, and demonstrated that these were equal to the third step. E then asked how many pieces like the third step could be made out of the sixth step. Moreover, it was illustrated that three steps like the first one made up the third step and two steps like the third made up the sixth step; therefore, three units taken two times equals six. Next, E removed the extra felt pieces and asked S to add steps seven through ten (1 x 7 to 1 x 10 inches) to the stairway. Finally, E asked how many pieces like the first one could be made out of the various steps both with the steps as a stairway and in random order.

The training procedure was individualized so that if S responded incorrectly, he was immediately given an extra training loop on that step and allowed to correct his error. Criterion was reached when S was able to perform each part of the training procedure without error. After S reached criterion, an immediate posttest, identical to the C pretest, was given. Experimental Ss in levels three and two were given C training. Control Ss in the same levels received the C immediate posttest.

Additive composition of classes (ACC) training. The training procedure for ACC (see Appendix Q) was similar to that used by Morf (1959) in his first experiment, except the present method was standardized and Ss were trained to criterion. This procedure, as the one above, consisted of two parts. For the first part, E presented two round yellow beads, eight round green beads, and five square blue beads, all made of wood, and asked S if there were more green beads or more round beads. His answer was checked by using a notched wooden rectangle which allowed the green beads and then all the round beads to be put in a row so that a comparison could be made.

Next, E said that a girl wanted to make a necklace of round beads only and asked S what colors the beads in the necklace would be. E further asked, "Which necklace would be longer, one of round beads or one of green beads?" S's answer was checked by actually putting the beads on a string with the round green ones first and then adding the round yellow ones. Next, the beads were exchanged so that there were two round green beads, eight round yellow beads, and five square blue beads. The above procedure was repeated except E asked S to compare the number of yellow, rather than green, beads with the number of round beads. Finally, E asked S to focus attention upon the round beads and wooden ones. The same procedure was carried out again except this time S was asked to compare the number of round beads with the number of wooden ones.

For the second part, E presented two blue and eight orange wooden rhythm sticks and asked whether there were more orange or more wooden sticks. S's answers were checked by lining the sticks up, first only the orange ones and then all of them. The sticks were then exchanged so that there were two orange and eight blue sticks, and E asked whether there were more blue or more wooden sticks. Finally, four blue wooden blocks were added and E asked if there were more blue things or more wooden things.

The training procedure was individually programmed so that if an S made an error, he was immediately given an extra training loop and allowed to correct his error. Criterion was reached when S was able to complete both parts without error. An immediate posttest, identical to the ACC pretest, was given following criterion. Experimental Ss in all three levels received ACC training. Control Ss in all levels received the ACC immediate posttest.

Final posttests

The six final posttests, identical to the six pretests, were administered at least one week after the immediate posttest. In some cases, however, there was approximately a three week's delay between the two posttests. The lack of a consistent time limit resulted from the variable time between S's reaching criterion on each task and the final posttests given as a block in two sessions. An attempt was made to keep the delay to approximately a week by administering the first three posttests as one session before S had reached criterion on O, C, and ACC training for level three. Since the order of the training was the same from DQ to ACC training, there was a longer delay between the immediate and final posttests on DQ, O, and C.

Mathematical test

All Ss were given tests in mathematics from the Cooperative Primary Test series. Mathematics Form 12A was given prior to participation in the study, and Mathematics Form 12B was given approximately five months later, immediately after posttesting was completed. Finally, an attempt was made to give Mathematics Form 12A again a year after Ss had received Form 12B.

The purpose of administering such a test was to determine whether training affects arithmetic ability. The selection of a test was quite difficult since the usual problem of measuring the effects of a new program was obvious. The question was whether to use the traditional achievement tests or whether to develop new ones more attuned to measuring the abilities dealt with in this project. After consideration of different achievement tests, as well as the time element, it was decided to administer the above standardized tests.

Results

Stages on each of the six pretests were determined for all Ss who completed the pretest sessions. The scoring of the stages was on a five-point, rather than three-point, scale in order to facilitate scoring the transitions between stages. Two judges independently scored 33 Ss on the six pretests. Spearman rank correlation coefficients between the two judges were .94, .81, .97, .81, .91, and .97 for DQ, Corr, CQ, O, C, and ACC respectively. One of the judges then rated stages for the remaining Ss on the six pretests.

Because the tests had unequal numbers of questions, the amount correct was computed as the percentage of total possible correct for comparison purposes. Figures 2.1, 2.2, and 2.3 show for each level the mean percentage correct for the experimental and control groups on the pre- and final posttests.

The data from the immediate posttest which was given upon S's reaching criterion were compared with the data from the final posttest given approximately one to three weeks later by means of the t test for related samples. No significant differences ($p > .05$) were found between any of the two posttests ($t = .51$, $df = 17$; $t = .18$, $df = 17$; $t = 1.00$, $df = 29$; $t = .99$, $df = 29$; and $t = .99$, $df = 35$ for the DQ, Corr, O, C, and ACC respectively).

The final posttest data were subjected to treatments x levels analyses of variance adjusted for the disproportionate number in the groups. An arcsin transformation was performed since the data were reported in percentages. A separate analysis of variance was performed for each of the six posttests. A significant treatment effect ($df = 1/65$, $p < .01$) was found on all six final posttests ($F = 50.92$, 22.12, 41.73, 17.67, 11.00, and 292.48 for the DQ, Corr, CQ, O, C, and ACC posttests respectively), indicating that the experimental

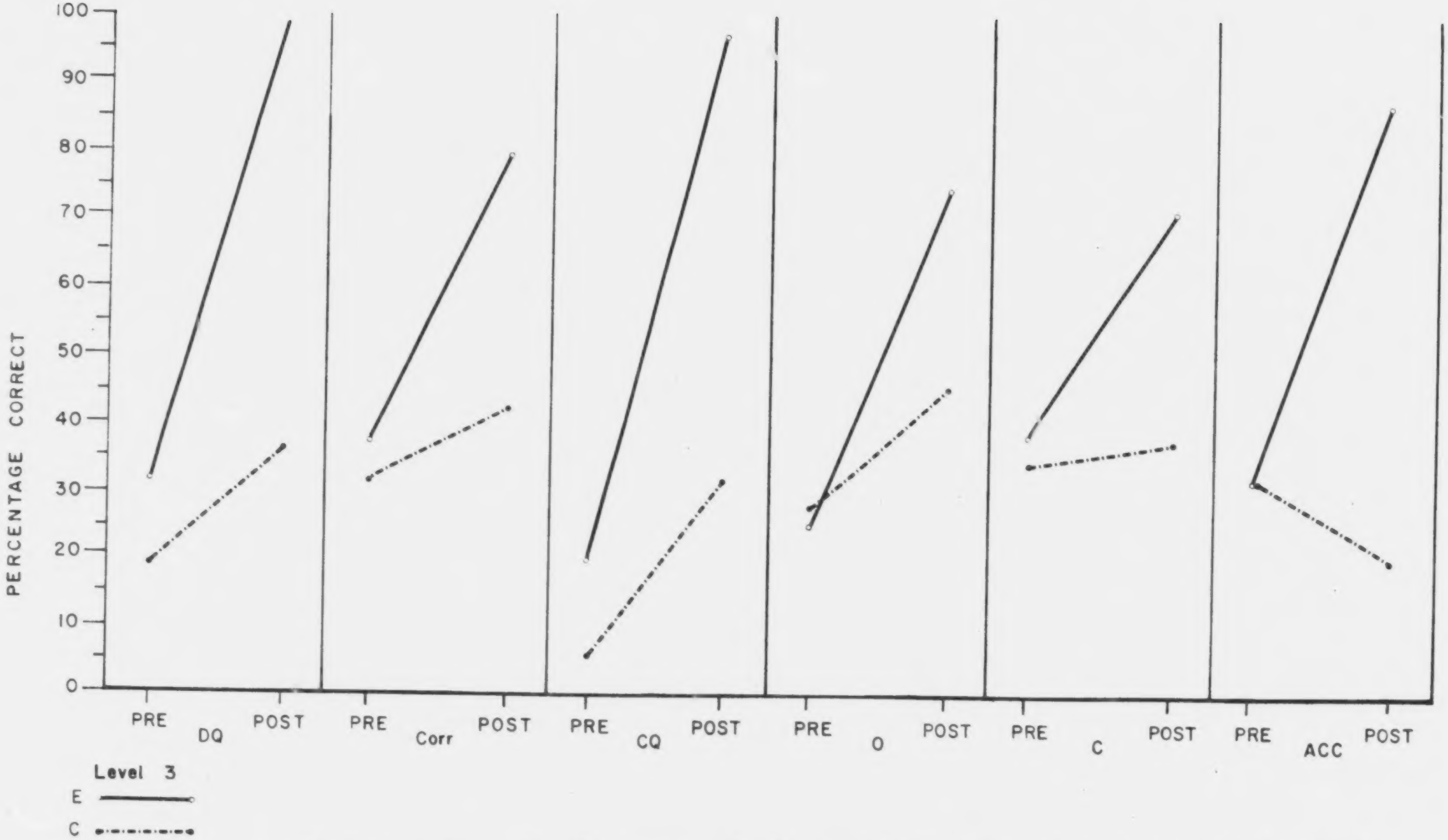

Figure 2.1 Performance of the two treatment groups at level three on the DQ, Corr, CQ, O, C, and ACC pre- and posttests.

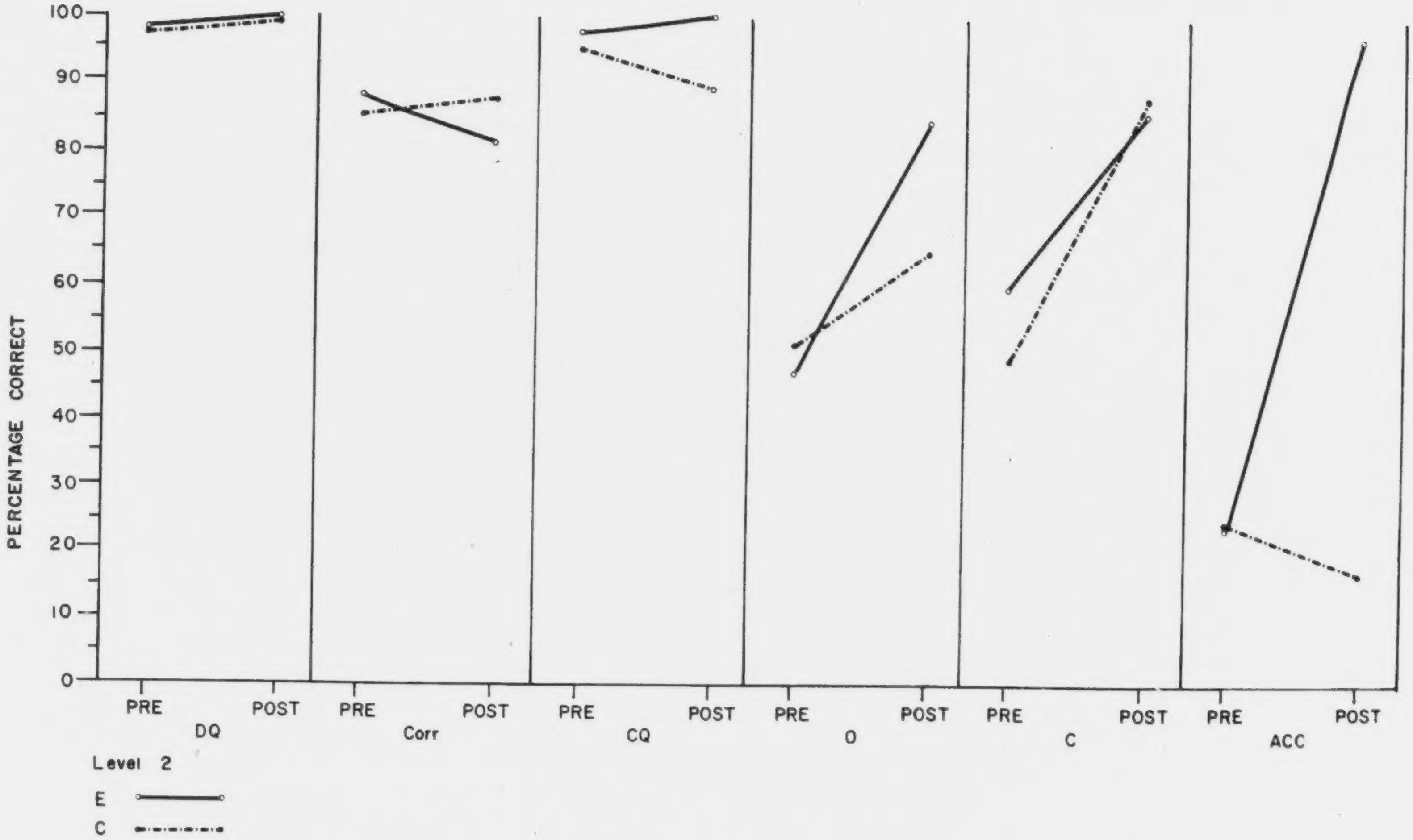

Figure 2.2 Performance of the two treatment groups at level two on the DQ, Corr, CQ, O, C, and ACC pre- and posttests.

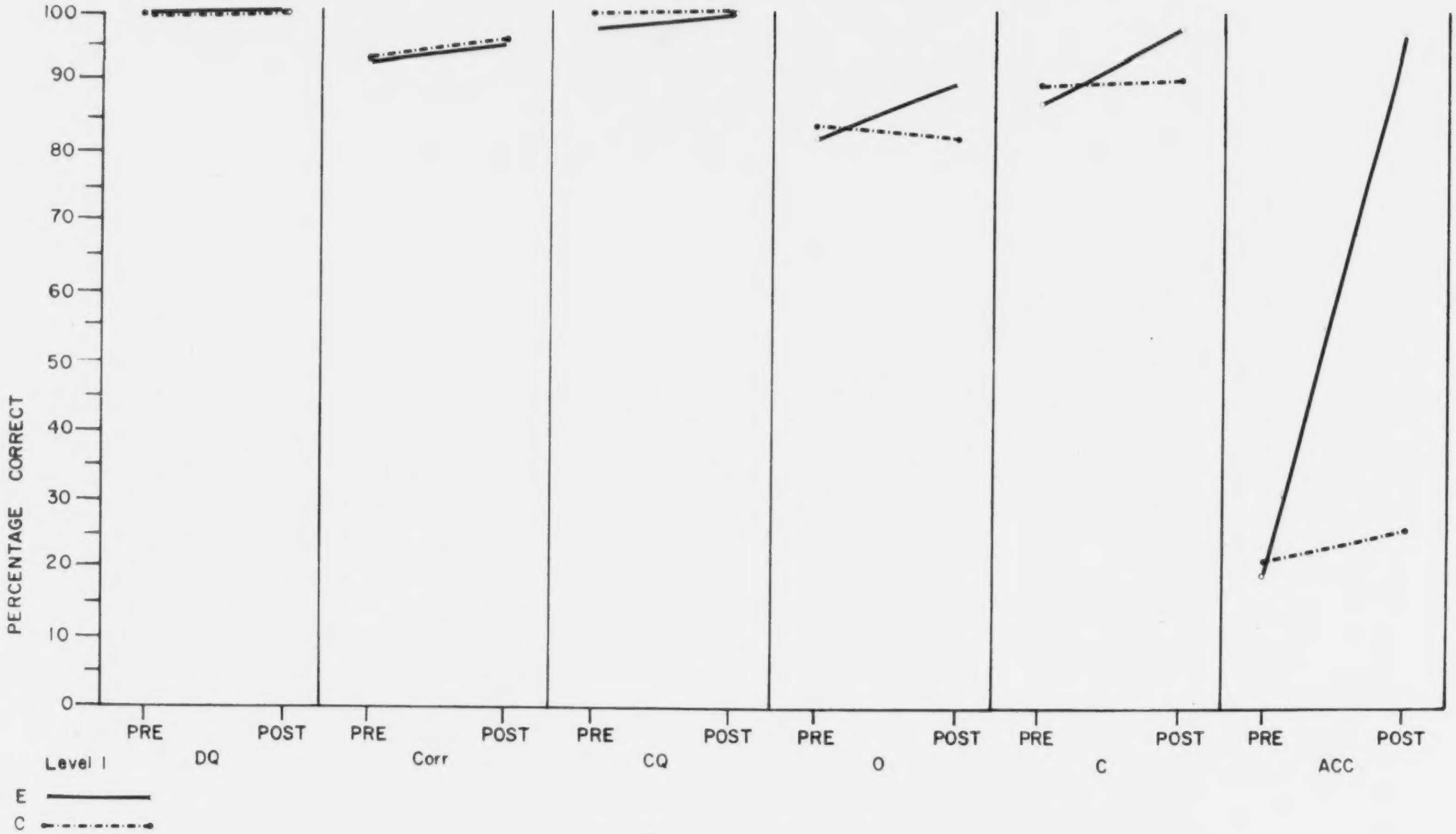

Figure 2.3 Performance of the two treatment groups at level one on the DQ, Corr, CQ, O, C, and ACC pre- and posttests.

group differed from the control group on all posttests. A significant level effect ($\underline{df}$ = 2/65, $\underline{p} < .01$) was found on all

Table 2.2

Significant differences between levels within the experimental and control groups.

Test		Experimental			Control		
	Levels	L_1	L_2	L_3	L_1	L_2	L_3
	L_1						*[1]
DQ	L_2						*
	L_3						
	L_1		*	*			*
Corr	L_2						*
	L_3						
	L_1						*
CQ	L_2						*
	L_3						
	L_1					*	*
O	L_2						
	L_3						
	L_1			*			*
C	L_2						*
	L_3						
	L_1						
ACC	L_2						
	L_3						

[1] The asterick indicates that the levels differed beyond the .05 level.

final posttests except ACC (df = 2/65, $p > .05$), indicating the superiority of some level(s) (F = 30.60, 35.64, 20.00, 8.95, 22.22, and 2.90 for the DQ, Corr, CQ, O, C, and ACC posttests respectively). A significant interaction (df = 2/65, $p < .01$), Treatments x Levels, was found for the DQ, Corr, and CQ final posttests only (F = 28.88, 5.83, and 16.36 respectively). The Treatments x Levels interaction was not significant (df = 2/65, $p > .05$) for the O, C, and ACC posttests (F = .77, 2.62, and 1.35 for the O, C, and ACC posttests respectively).

Multiple comparisons among the levels within each treatment group were made by means of the Newman-Keuls test at the .05 level. Table 2.2 summarizes the differences found between levels within the control and experimental groups. Multiple comparisons were also made between the experimental and control groups within each level by means of 1 x 2 analyses of variance. Table 2.3 summarizes the differences found between the experimental and control groups at the three levels.

Table 2.3

Differences between the experimental and control groups by levels on the six final posttests.

Final	Levels		
Posttest	1	2	3
DQ			$E > C$[1]
Corr			$E > C$
CQ			$E > C$
O		$E > C$	$E > C$
C			$E > C$
ACC	$E > C$	$E > C$	$E > C$

[1] The experimental group was significantly superior to the control group beyond the .05 level.

In order to distinguish between a response set to say "same" and the actual acquisition of conservation, the explanations for answers on the DQ, Corr, and CQ posttests were examined for the control and experimental Ss who were trained in conservation. Tables 2.4, 2.5, and 2.6 show the distribution of experimental and control Ss in level three who gave at least one conserving reason for their answers on the DQ, Corr, and CQ posttests respectively. The experimental and control groups differed significantly in proportion of Ss who reported conserving reasons on all three tests

Table 2.4

Distribution of experimental and control _S_s in level three who gave conserving reasons on the DQ posttest.

Group	No conserving reason	At least one conserving reason	Total
Experimental	2	16	18
Control	10	4	14
Total	12	20	32

Table 2.5

Distribution of experimental and control _S_s in level three who gave conserving reasons on the Corr posttest.

Group	No conserving reason	At least one conserving reason	Total
Experimental	3	15	18
Control	10	4	14
Total	13	19	32

Table 2.6

Distribution of experimental and control _S_s in level three who gave conserving reasons on the CQ posttest.

Group	No conserving reason	At least one conserving reason	Total
Experimental	4	14	18
Control	11	3	14
Total	15	17	32

($X^2 = 9.79$, _df_ = 1, $p < .01$; $X^2 = 7.65$, _df_ = 1, $p < .01$; and $X^2 = 7.91$, _df_ = 1, $p < .01$ on the DQ, Corr, and CQ posttests respectively).

Moreover, the reliability of the six tests was determined by examining the correlations between the pre- and posttest scores for the control group which received no training. The Pearson product-moment correlation coefficients between pre- and posttest scores were .83, .86, .78, .53, .48, and .27 for the DQ, Corr, CQ, O, C, and ACC tests respectively.

Relationships among the pretests were examined by means of Pearson product-moment correlations between pretest scores for all Ss. Table 2.7 shows the correlation coefficients between the six pretests. All tests, except ACC, showed significant positive correlations with each other. The ACC test, on the other hand, showed significant negative correlations with DQ, Corr, and O. ACC and CQ as well as ACC and C were not significantly related.

Table 2.7

Relationships among the six Piagetian pretests.

	Tests					
Tests	DQ	Corr	CQ	O	C	ACC
DQ		.92**	.91**	.53**	.40**	-.27*
Corr			.90**	.60**	.39**	-.37**
CQ				.55**	.40**	-.21
O					.34**	-.36**
C						-.08
ACC						

** $p < .01$, df = 69

* $p < .05$, df = 69

The relationships between the pretests and individual differences, such as CA, MA, and IQ were also examined. The Pearson product-moment correlation coefficients are presented in Table 2.8. Significant positive relationships were found between MA and the DQ, Corr, CQ, O, and C pretest scores and between CA and the DQ, Corr, CQ, O, and C pretest scores. Significant positive relationships were also found between the first given mathematics test, Form 12A, and the DQ, Corr, CQ, and O pretest scores.

The control and experimental groups' performance (see Table 2. 9) on the mathematical tests were examined by means of the t test. Each level was considered separately since it was believed that level three which received five different types of training would show more effect than level one which

Table 2.8

Relationships between the
six Piagetian pretests and IQ, MA, and CA.

	Pretests					
	DQ	Corr	CQ	O	C	ACC
IQ	.12	.17	.14	.20	.18	-.02
MA	.64**	.65**	.62**	.53**	.49**	-.20
CQ	.56**	.54**	.53**	.41**	.40**	-.19
Math 12A	.36**	.33**	.32**	.36**	.27	-.20

**$p < .01$, df = 67, 69

Table 2.9

Performance of the experimental
and control *S*s on the mathematical tests.

Test	Level	Experimental			Control		
		n	Mean score	SD	n	Mean score	SD
Math 12A	L_1	6	41.50	5.99	8	33.75	21.03
	L_2	12	28.67	17.78	13	35.46	12.75
	L_3	18	26.67	11.10	14	20.79	12.56
Math 12B	L_1	6	40.33	4.76	8	43.00	4.21
	L_2	12	35.67	7.52	13	34.69	11.70
	L_3	18	26.39	10.03	14	21.07	9.78
Math 12A (Retest)	L_1	4	45.00	4.00	3	47.00	2.08
	L_2	7	41.57	3.26	5	42.20	5.22
	L_3	11	36.00	6.66	7	29.86	5.34

received only ACC training. Before training, no significant differences ($p > .05$) were found between the control and experimental groups at the three levels on Form 12A (t = .87, df = 12; t = 1.11, df = 23; and t = 1.40, df = 30 for levels one, two, and three respectively). Moreover, no significant differences ($p > .05$) were found between the experimental and control group at the three levels on Form 12B given right after final posttesting ($t = 1.22$, $df = 12$; $t = .25$, $df = 23$; and $t = 1.69$, $df = 30$ for levels one, two, and three respectively), although the difference at level three approaches significance at the .05 level for a one-tailed test. Finally, the data from Form 12A, given one year after completion of the study, were analyzed. Data from only 37 of the 71 original *Ss* were available. No significant differences were found between the experimental and control groups at levels one and two, although a significant difference was found at level three ($t = .91$, $df = 5$, $p > .05$; $t = .26$, $df = 10$, $p > .05$; and $t = 2.05$, $df = 16$, $p < .05$ one-tailed).

Moreover, relationships between training effectiveness as measured by the amount of improvement from pre- to posttest and individual differences were determined. Table 2.10 shows the correlation coefficients between training effectiveness and IQ, MA, CA, and pretest scores. The degrees of freedom are different throughout the table since different numbers of *Ss* received each type of training depending on level. No significant relationships were found between training effectiveness and IQ, MA, or CA. Significant negative relationships, however, were found between amount of improvement and pretest scores.

Table 2.10

Relationships between test improvement from pre- to posttest and individual differences for the *Ss* who received training.

Test Improvement	IQ	MA	CA	Pretest score
DQ	.22	-.10	-.23	-.65**
Corr	.48	.11	-.02	-.80**
CQ	.18	.13	.04	-.96**
O	.17	-.12	-.20	-.74**
C	-.04	-.18	-.16	-.74**
ACC	.20	.33	.23	-.73**

** $p < .01$, $df = 16, 28, 34$

An analysis of variance for repeated measures was used to determine which was the easiest, or first occurring, of the six pretests. For the 71 Ss, means for the DQ, Corr, CQ, O, C, and ACC pretests were .66, .64, .59, .46, .52, and .26 respectively. The analysis of variance yielded significant results ($F = 19.27$, $df = 5/350$, $p < .01$). The Newman-Keuls test of multiple comparisons showed significant differences ($p < .05$ between Ss' performance on the DQ pretest and the O, C, and ACC pretests (see Table 2.11). Differences were also found between performance on the Corr pretest and the O, C, and ACC pretests and between performance on the CQ pretest and the O and ACC posttests. Moreover, performance on both the O and C pretests differed significantly from the ACC pretest. All other differences were nonsignificant.

Table 2.11

Significant differences between performance on the six pretests.

Test		DQ	Corr	CQ	G	O	ACC
	Mean	.66	.64	.59	.52	.46	.26
DQ	.66	-			★[1]	★	★
Corr	.64		-		★	★	★
CQ	.59			-		★	★
C	.52				-		★
O	.46					-	★
ACC	.26						-

[1] The asterick indicates performance on the two pretests differs beyond the .05 level.

Discussion

At level three, the experimental group was significantly superior to the control group on each of the final posttests (see Table 2.3). The superiority of the experimental group in this level, at which Ss had previously failed all pretests, lends support to the first three hypotheses that conservation, ordination, cardination, and classification can be accelerated in retardates. The extent of the acceleration on DQ, Corr, CQ, O, and C can be assessed by comparing the performance of level three with level one on the final posttests (see

Table 2.2). The latter level reflected maximum performance on these tests since Ss who were at Piaget's stage three on all tests except ACC were assigned to level one. Significant differences between level one and three in the experimental group were found only on the Corr and C posttests, indicating that Corr and C training were not optimally beneficial to Ss at level three. DQ and O training, on the other hand, appear to have been optimally effective since level three did not differ significantly from level one in the experimental group, although there was such a difference in the control group. It also appears as if training on DQ transferred to CQ since optimal performance was also found on the CQ posttest. These results are similar to those previously found in Experiment I. Moreover, ACC training also appears to have been extremely beneficial for Ss in level three; no differences were found among the three levels on ACC. Although the control group showed poor performance on both the ACC pre- and posttest at all levels (see Figures) the experimental group which also had shown poor pretest performance performed near maximum at all levels on the posttest.

At level two, the experimental group was significantly superior to the control on the O and ACC posttests (see Table 2.3), indicating that O and ACC training facilitated performance. Since no difference was found between level two and one within the experimental group for these tests, O training appears to have been optimally beneficial. Moreover, ACC **posttest** scores were near maximum so ACC training also appeared highly beneficial. C training, on the other hand, appears to have been ineffective at level two. One must note, however, a sizeable increase from pretest to posttest in the control group (see Figure 2.2). It is possible that being given both the C and O test, which is related to C, three times each may have been in itself beneficial to these Ss who were intermediate in performance. That is, learning may have taken place with each presentation of the tests so that the control group became comparable to the experimental group in performance on the C test.

At level one, all Ss were originally low in performance on the ACC pretest. On the final posttest, however, the experimental group was significantly superior to the control group, indicating that ACC training was effective. Moreover, the experimental group showed near perfect performance, indicating that ACC training was optimally effective.

The above results indicate that retardates can be taught conservation, ordination, cardination, and classification as demonstrated by data from Ss in level three (Piaget's stage one). The experimental group was significantly superior to control group on all posttests, thus supporting hypotheses a, b, and c. Moreover, DQ, O and ACC training appear to have been optimally beneficial. For Ss with intermediate ability, moreover, O and ACC training procedures were effective, but C was not. ACC training, on the other hand, appeared optimally effective.

A unique problem with DQ conservation training is the issue of whether the Ss acquired a response set to say "same" or whether they actually acquired conservation. In this study, similar to Experiment I, Ss appeared to acquire conservation. The high proportion of Ss in the experimental versus control group (see Tables 2.4, 2.5, and 2.6) who gave conserving reasons lends support to this conclusion. Moreover, Ss in this study were also trained on nonequivalent transformations in which the correct response was not "same." The latter particularly would not lead to a response set to say "same" since at some point in training this response was incorrect.

The coefficients of stability for the six pretests show that DQ, Corr, and CQ have a fairly high degree of reliability (.81, .86, and .78 respectively). The coefficients of the remaining three tests, O, C, and ACC, showed only moderate or little reliability (.53, .48, and .27 for O, C, and ACC respectively). It is interesting to note, however, that reliability generally decreased with test difficulty. The decrease in reliability probably resulted from the more restricted range of scores on the difficult tests, particularly ACC on which all Ss showed low performance.

The correlations between the six pretests showed strong positive relationships among the three conservation pretests, DQ, Corr, and CQ (see Table 2.7). Moreover, O appeared more strongly related to the conservation tests than did C, and O and C were not as strongly related as expected, thus lending little support to Piaget's hypothesis that "cardination always involves ordination, and vice versa..." (Piaget 1952, p. 122). On the other hand, ACC showed negative relationships with the DQ, Corr, and O tests. It appears that Ss who did more poorly on these three tests tended to score higher on ACC; the Figures show an increase in mean ACC pretest scores from level one to three.

IQ score does not appear to be related to performance on the Piagetian pretests (see Table 2.8). On the other hand, similar to findings in other studies, (Experiment I; Achenbach, 1969; Goldschmid, 1967; Kooistra, 1963) performance on the pretests, except ACC, appeared to be highly related to MA. Moreover, performance on all pretests, except ACC, appeared to be related to CA.

On the other hand, no relations were found between MA, CA, or IQ and training effectiveness as measured by amount of improvement from pre- to posttest (see Table 2.10). It appears that training was not selectively beneficial to Ss depending on their IQs or CAs. On the other hand, the lower an S's score on the pretest, the more likely he was to show large improvement after training. The higher the pretest score, of course, the less improvement possible. Consequently, the significant negative relationships between pretests and improvement indicate that training was generally successful regardless of S's performance on the pretest. The above results are in contrast to those of previous studies (Beilin, 1965; Lumsden & Kling, 1969; Overbeck & Schwartz, 1970; Strauss & Langer, 1970) but in agreement with those of Experiment I. It appears that neither CA nor pretest performance were important factors in training effectiveness. The general training effectiveness is believed to have resulted from the individual programming and running each S to criterion.

Evidence for hypothesis five that training affects mathematical ability must be interpreted with caution since, although significant differences were obtained as expected at level three, only about one-half of the original Ss were available. Moreover, no differences were found between the experimental and control groups at level three on Form 12B, although it is likely that some time was needed before the effects of training on arithmetic ability were apparent. Lack of strong, conclusive results may indicate that conservation, ordination and cardination, and additive classes training is unrelated to arithmetic ability. The results of this study and others (Dodwell, 1961; Hood, 1962), however, indicate a significant relationship between Piagetian concepts and mathematical ability. Furthermore, the above results may indicate that conservation, ordination, cardination, and classification may be necessary, but not sufficient, conditions. Piaget (1952) and his colleagues were not concerned about the distinction between necessity and sufficiency and merely pointed out the necessity of conservation. It is felt, however, that the reason for not obtaining more conclusive results is that the mathematical test measures abilities other than those accelerated by training. An inspection of the test showed very few items directly related to the training program, that is, items related to conservation, ordination, cardination, and classification. Consequently, the full benefit received by the experimental Ss probably could not have been measured by the mathematical test; nor could it have been measured by any of the other available standardized tests which are similar in emphasis.

The repeated measures analysis of variance on the six pretests was used to determine which was the first occurring, or least difficult, of the six operations. In contrast to previous results (Experiment I), no significant differences were found in performance on the DQ, Corr, and CQ tests (see Table 2.11). Selection of Ss in the previous study, however, may account for the difference since Ss were selected only if they failed the conservation pretests. In the present study, Ss who failed the conservation pretests composed level three only. All other Ss passed these pretests, and, consequently, differences in performance on the conservation tests may not have been apparent in this study. The means, however, were similar in order to those obtained previously in Experiment I. Moreover, the O and C pretests did not differ in difficulty, and both were more difficult than the three conservation pretests. Finally, the ACC pretest appears to have been the most difficult; performance on it was significantly lower than performance on any of the other tests.

In summary, the results of the study showed that conservation can be accelerated, supporting the first hypothesis, although there was some question about whether Corr training was optimally effective. O and C training also appeared to be facilitating, lending qualified support for hypothesis two, although caution must be exercised since the effect of C training was not constant across all levels. In addition, training on classification (ACC) appeared to be optimally effective, thus supporting hypothesis three. Moreover, performance on all pretests, except ACC, was related to MA, supporting hypothesis four. On the other hand, evidence for the hypothesis that training affects arithmetic ability as measured by a standardized test appeared inconclusive. The results of this study indicate that it is possible to facilitate Piagetian-type concepts in retardates through concentrated training efforts. Moreover, some of the training procedures, namely DQ, O, and ACC, were so effective that they allowed a retarded child originally at Piaget's preoperational thought to show performance indicative of the level of concrete operations.

Experiment III

The Acquisition of Conservation of Quantity by Institutionalized Retardates.[1]

ABSTRACT. The present study consisted of a replication of Experiment I with institutionalized retardates who were higher in CA and lower in MA than Ss in the previous study. Forty-five nonconserving or partially conserving Ss were assigned to one of four treatment groups--discontinuous quantity training, correspondence training, continuous quantity training, and a control condition. The hypotheses were (a) conservation of quantity can be accelerated, (b) training effects on one form of conservation transfers to other forms of conservation, (c) ability to conserve is related to MA, and (d) discontinuous quantity conservation is easier than continuous quantity conservation. The results supported all, except hypothesis c. No relationship was found between pretest performance and MA.

Considerable success has been experienced in recent years in accelerating cognitive development in normal children. Few studies, however, have been concerned with accelerating cognitive development in retarded children, in spite of its greater practical application. Lister (1969, 1970) has reported success in training educationally subnormal, or mildly retarded, children to conserve weight and volume; she used a variety of methods and materials in a flexible but standardized training procedure. Furthermore, Experiment I has shown success in accelerating conservation of quantity in educable retardates, and Experiment II has shown success in accelerating conservation of quantity, ordination, cardination, and classification in educable retardates. The training procedures, which were standardized but individually programmed, were most facilitating for discontinuous quantity conservation, ordination, and classification. Generally, no relationships were found between individual differences, such as IQ, MA, or CA, and amount of improvement in performance after training, although significant positive relationships were found between MA or CA and pretest scores. Of particular interest also, were the significant negative relationships between improvement after training and pretest scores. The above findings indicate that training was generally effective regardless of S's IQ score or age.

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[1] This study was done in collaboration with Dr. M. LeRoy Reynolds and Mrs. Jean Holland, both on the faculty of Central Michigan University, Mount Pleasant, Michigan.

In view of the general effectiveness of the training procedures in the previous studies, it was decided to examine their effectiveness with a different population. The present study consisted of an attempt to replicate the findings of Experiment I with institutionalized retardates whose IQs were lower and CAs were higher than those of Ss in the previous studies. It was believed, because of the overall success of the training procedures regardless of individual differences, that these training procedures would also be effective with institutionalized retardates. The specific hypotheses are (a) conservation of quantity can be accelerated in institutionalized retardates, (b) training effects on one form of conservation transfers to other forms of conservation, (c) ability to conserve before training is related to MA, and (d) discontinuous quantity conservation is easier than continuous quantity conservation.

Method

Subjects

Ss were 45 (24 trainable and 21 educable) retardates, 22 females and 23 males, from a local institution for retarded children and adults. The Ss were selected from a sample of 52 testable Ss on the basis of performance on a vocabulary and three Piagetian conservation tests--discontinuous quantity (DQ), correspondence (Corr), and continuous quantity (CQ). Ss were selected for participation in the study if they passed the vocabulary test but failed to exhibit conservation on at least two of the three Piagetian pretests.

The mean chronological age (CA) available for 44 of the Ss was 18.05 (SD = 6.78). The mean mental age (MA) available for 36 Ss was 6.47 (SD = 2.10). The mean Peabody Picture Vocabulary Test (PPVT) score available for 43 Ss was 52.32 (SD = 12.65). The 45 Ss were randomly assigned to four treatment groups, of which three received training and one served as a control.

Procedure

The design of this experiment (see Table 3.1) was similar to Experiment I. All Ss were given three Piagetian tests upon passing the vocabulary pretest and, if not at Piaget's stage three on more than one of the pretests, they were randomly assigned to one of four treatment groups. Three of the groups were given training on one form of conservation, while the fourth was given a control task. Finally, all Ss, irrespective of treatment, received the same three tests again as the final posttests. Three Es administered the testing and training sessions following a standardized procedure. An E served as an observer (O) and recorded all responses for each session.

Table 3.1

Design of study showing
the four groups and their different treatments.

DQ Training	Corr Training	CQ Training	Control
Pretests: DQ Corr CQ	Pretests: DQ Corr CQ	Pretests: DQ Corr CQ	Pretests: DQ Corr CQ
Treatment: DQ training	Treatment: Corr training	Treatment: CQ training	Treatment: Same as DQ training but with no reversals
Immediate posttest: DQ	Immediate posttest: Corr	Immediate posttest: CQ	Immediate posttest: DQ
Final posttest: DQ Corr CQ	Final posttest: DQ Corr CQ	Final posttest: DQ Corr CQ	Final posttest: DQ Corr CQ

Pretests

Vocabulary pretest. A vocabulary pretest was administered to determine whether *S* understood the meaning of words, such as "same," "more," "less," and "as many as," used on the Piagetian tests. *Ss* not responding appropriately to verbal commands of at least "more" and "same" were eliminated from further participation in the study. All *Ss* who passed the vocabulary test were given the conservation tests in the following order: discontinuous quantity, correspondence, and continuous quantity conservation.

Conservation of discontinuous quantity (DQ) pretest. The DQ test was identical to that given in Experiment I. A detailed description of the test is included in Appendix C. *S* was given a choice of yellow or green beads. *E* and *S* then placed their beads into two equal 600 ml. glass beakers, one at a time, and S was asked if they both had the same number of beads. After equivalence had been established, S was asked whether necklaces made from the beads would be the same length. A series of transformations followed: S's beads were poured from his 600 ml. beaker into a 150 ml. beaker, into a 150 x 75 mm. glass dish, divided into two 250 ml. beakers, and then divided among four 150 ml. beakers. After each transformation, S was asked whether they had the same number of beads and whether necklaces made from their beads would be the same length. Reasons for each response were elicited.

Correspondence (Corr) pretest. The Corr test was identical to that used in Experiment II. For a detailed description of this test, see Appendix E. E constructed three models from plastic chips and asked S to "take the same number of chips from your pile and make the same thing I just did." The models consisted respectively of a cross of 9 chips, two parallel rows of 7 chips each, and a rhombus of 12 chips. For each model, after S was satisfied that he had put out the same number of chips, E spread (transformed) the chips in the model and asked if they still had the same number. E also elicited reasons for S's response. The same procedure was repeated for each model, but S was asked to duplicate the model with wooden sticks, instead of chips.

Continuous quantity (CQ) pretest. The CQ test was identical to that in Experiment I. A more detailed description is given in Appendix F. S was given his choice of two colored clay balls. E took the other ball and asked S if they had the same amount of clay. Adjustments were made until S believed the two amounts equal. E then successively transformed S's ball into a sausage, a pancake, two balls, three balls, four balls, and finally from the four balls into a sausage, a pancake, a cube, and a cup. After each transformation, S was asked if they had the same amount. S was also asked to give reasons for his responses.

Treatment

All Ss who were judged to be at stage three on more than one of the above three Piagetian tasks were eliminated from the study. The remaining Ss were randomly assigned to one of four treatment groups. Three groups received training related to DQ, Corr, or CQ, and the fourth served as a control. Each treatment session approximated one-half hour in time.

The training sessions were individually programmed by the use of two training cycles for each transformation identical to Study I (see Table 1.2). The first cycle consisted of (a) establishing equivalence between two quantities, (b) transforming one quantity perceptually in form, (c) having S judge the equivalence of the two quantities after the transformation, and (d) checking the correctness of S's response by reversing the transform to its original state. If S gave an incorrect response on cycle one, cycle two immediately followed. For cycle two, steps a, b, and c were identical to those above. If S still judged that the two quantities were unequal after transformation, he was asked to add or take away until he believed them equal. Again his response was checked by reversing the transform to its original state. S was then shown that the quantities were now unequal by the amount that he took away or added. Training was carried out to criterion on all training tasks. When cycle two was no longer needed for any part of the training task, S was said to have reached criterion.

DQ training group (n = 12). The DQ training procedure was identical to that used in Experiment I. A more detailed version is included in Appendix K. The materials consisted of rectangular erasers with varying sizes of wooden boxes and sticks with varying sizes of decorated tin cans. Using the erasers and boxes, equivalence was first established by E and S each putting erasers in two small identical boxes, one at a time, until the bottoms were covered, and having S judge the equivalence of the two amounts. Then S's erasers were transformed by pouring them into the different sized boxes, dividing them between two boxes, and then dividing them among four boxes. Cycle one and cycle two, if necessary, were carried out for each of the above transforms.

The same procedure was followed for sticks and cans. After S confirmed that there were two equal quantities of sticks in two small identical cans, transformations were carried out by spreading out S's sticks in a larger can or combination of cans. Cycle one and cycle two, if needed, were carried out for each of the above transforms. When criterion was reached, i.e., no errors were made on any of the tasks, an immediate posttest, identical to the DQ pretest, was given.

Corr training group (n = 9). The Corr training procedure was identical to that used in Experiment I. The original version is included in Appendix L. A quantity of 35 mm. film containers (cans) and their covers were used as materials. Equivalence between number of covers and cans was established by having S put a cover on eight containers in a line. Transformations were made by removing the covers and putting them in front of the cans, but farther apart or closer together. If S failed to conserve after any transformation, cycle two was immediately given. The above procedure was carried out to criterion for a single row, an open square, a closed square, and a square of covers formed away from the square of cans. After criterion, which consisted of no errors, was reached for each figure in succession, an immediate posttest, identical to the Corr pretest, was given.

CQ training group (n = 10). The CQ training procedure was also identical to that used in Experiment I. A detailed copy is included in Appendix N. Equivalence was established by pouring equal amounts of "pop" (colored water) into two 600 ml. glass beakers. Following S's statement of equivalence, his "pop" was poured successively into a 150 x 75 mm. glass dish; two 250 ml. beakers; one 250 ml. and two 150 ml. beakers; four 150 ml. beakers; and one 150 ml. beaker, one 250 ml. beaker, one 600 ml. beaker, and one 150 x 75 mm. dish. Cycle one was carried out with each of the above transformations. If S failed to conserve, cycle two was immediately given for the same transform. S reached criterion when he was able to go through all transformations successively without error. Following criterion, an immediate posttest, identical to the CQ pretest, was administered.

Control (C) group (n = 5). The control procedure differed from that used in Experiment I in which control Ss received play sessions with clay. The C group in the present study used the same materials, erasers with boxes and sticks with cans, as the DQ training group, but no reversals were made and no feedback was given as to the correctness of the response. Consequently, control Ss did not receive cycle two. Equivalence was established by putting the erasers/sticks, one at a time, into two small equal boxes/cans, and having Ss make a statement about their equivalence. Then the same series of transformations as given in DQ training were carried out with each box/can or combination of boxes/cans, and S was asked about the equivalence of the two quantities after the transformation of one quantity. E did not respond to any of S's answers. When interest lagged, E and S engaged in a few minutes of play activity before continuing. The number of sessions given the control Ss was determined by calculating the average number of sessions Ss in training groups needed to reach criterion. The average number of one-half hour training sessions needed was 3 for educable Ss and 3.5 for trainable Ss. On the final control session, each S received an immediate posttest, identical to the DQ pretest, in order to equate the number of tests given to the training and control groups.

Final conservation posttests

Besides the immediate posttests which were given upon S's reaching criterion, final posttests, identical to the DQ, Corr, and CQ pretests were individually administered to all Ss at least one week after the immediate posttests.

Results

The 52 pretested children were scored independently by two judges for Piaget's three stages on each of the conservation pretests. The judges rated the Ss on a scale of one to five in order to facilitate scoring transition between Piaget's three stages. Spearman rank correlations between judges were .90, .83, and .94 for the DQ, Corr, and CQ pretests respectively. Any S who was in the third stage (rated as four or five) on more than one of the pretests was dismissed from further participation in the study. Forty-five Ss remained in the study; however, data from 9 Ss later had to be eliminated from the study because their seasonal vacations occurred before they received the final posttests. Consequently, all of the data were collected from only 36 Ss, although pretest data were available for 45 Ss. Unfortunately, 5 of the 9 Ss who were eliminated had been in the control group. Table 3.2 shows the number of Ss remaining in each group who were nonconservers, partial conservers, and total conservers on each pretest.

Table 3.2

Number of nonconservers, partial conservers, and total conservers in the four treatment groups on the three pretests.

Group	Test	Non-conservers	Partial conservers	Total conservers
DQ (n=12)	DQ	8	4	0
	Corr	12	0	0
	CQ	11	0	1
Corr (n=9)	DQ	6	3	0
	Corr	5	4	0
	CQ	7	1	1
CQ (n=10)	DQ	7	3	0
	Corr	7	2	1
	CQ	9	1	0
Control (n=5)	DQ	4	1	0
	Corr	4	1	0
	CQ	3	2	0

The number correct on each test was scored as the percentage of total possible correct for comparison purposes, since each test had a different number of questions. Weighted means of the total pre- and posttests were computed by weighting *S*s percentage correct by the number of questions on each test. Figure 3.1 illustrates the performance of the four groups on the pre- and posttests.

The final posttests were subjected to analyses of covariance, with pretest scores as the covariate; an arcsin transformation of scores was made prior to analyses. Significant differences were found between groups on the Corr and CQ posttests only ($F = 2.20$, $df = 3/31$, $p > .05$; $F = 4.58$, $df = 3/31$, $p < .01$; and $F = 4.55$, $df = 3/31$, $p < .01$ for the DQ, Corr, and CQ respectively). An analysis of covariance was also computed on the transformed weighted means of the posttests. A significant difference was found between the groups' weighted means ($F = 5.23$, $df = 3/31$, $p < .01$).

Multiple comparisons (Winer, 1962, p. 592) were made between the adjusted posttest means. Table 3.3 indicates the groups that differed significantly from each other. All training groups differed significantly from the control group on the Corr, CQ, and weighted mean of the total posttests. On the DQ posttest, however, no significant differences were found among the four groups.

In order to determine whether there were differences between performance on the immediate and final posttests over a one-week interval, a matched *t* test was computed on the data from the experimental groups. No significant differences were found between the posttests ($t = 1.40$, $df = 11$, $p > .05$ for the DQ posttest; $t = 1.06$, $df = 8$, $p > .05$ for the Corr posttest; $t = 1.25$, $df = 7$, $p > .05$ for the CQ posttest).

Pearson product-moment correlation coefficients were computed between the three pretests for all *S*s to examine the amount of relationship between performance on the tests. The correlation coefficient between the DQ and Corr pretests was .37, $df = 43$, $p < .05$, between the Corr and CQ pretests was .43, $df = 43$, $p < .01$, and between the DQ and CQ pretests was .50, $df = 43$, $p < .01$.

Moreover, Pearson product-moment correlation coefficients were used to examine the relationships between each pretest and measures of CA, MA, and IQ for all *S*s in the study for whom these data were available. The coefficients between the pretests and each of the above measures are given in Table 3.4. No significant relationships were found.

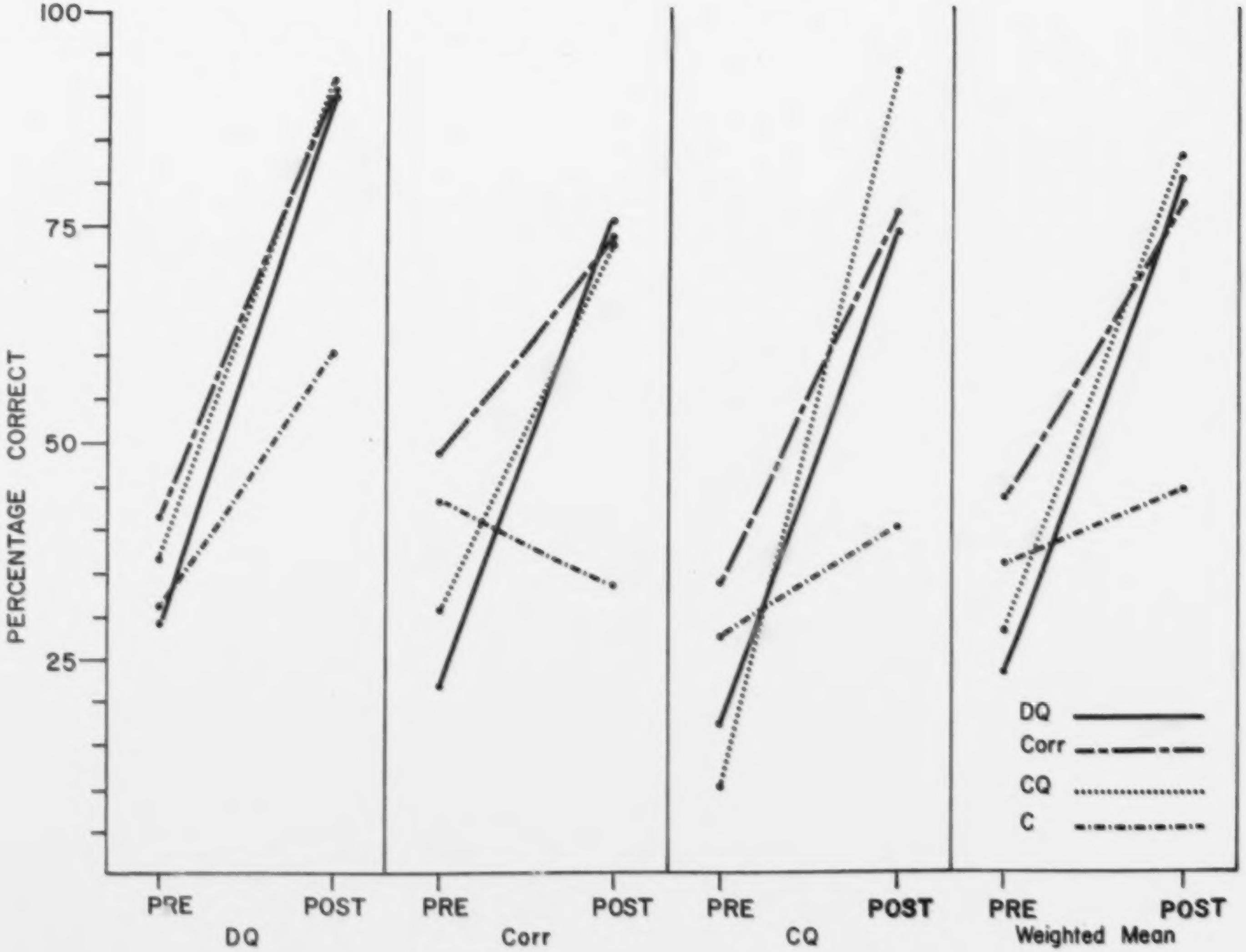

Figure 3.1 Performance of the four treatment groups on the DQ, Corr, and CQ pre- and posttests and the weighted means of the three pre- and posttests.

Table 3.3

Multiple comparisons
between the adjusted posttest means.

Posttests	Groups	DQ	Corr	CQ	C
DQ	DQ	-			
	Corr		-		
	CQ			-	
	C				-
Corr	DQ	-			*[1]
	Corr		-		*
	CQ			-	*
	C				-
CQ	DQ	-			*
	Corr		-		*
	CQ			-	*
	C				-
Weighted Mean of Posttests	DQ	-			*
	Corr		-		*
	CQ			-	*
	C				-

[1] The asterick indicates that these groups differed significantly beyond the .05 level.

The relationships between training effectiveness as measured by amount of test improvement after training and individual differences such as IQ, MA, CA, and pretest scores were also examined. Table 3.5 shows the Pearson product-moment correlation coefficients between these variables. No significant relationships were found between test

Table 3.4

Relationships between the pretest scores and individual differences.

Pretest	IQ[1]	MA[2]	CA[3]
DQ	.09	.32	.24
Corr	.06	.00	-.06
CQ	-.07	-.14	.05

[1] _df_ = 41
[2] _df_ = 34
[3] _df_ = 42

improvement and IQ, MA, or CA. Significant negative relationships, however, were found between amount of DQ improvement and DQ pretest score and between amount of Corr improvement and Corr pretest scores. On the other hand, no relationship was found between CQ improvement and CQ pretest scores.

Table 3.5

Relationships between test improvement from pre- to posttest and individual differences.

Test improvement	IQ	MA	CA	Pretest scores
DQ	.33	-.37	.21	-.84**
Corr	.04	.07	-.12	-.70**
CQ	.24	.17	-.03	-.17

** $\underline{p} < .01$, _df_ = 29

In order to determine which was the easiest of the three tests, an analysis of variance for repeated measures was performed on the transformed pretest scores for all Ss. The means of the three pretests were .35, .34, and .20 for DQ, Corr, and CQ respectively. The analysis of variance showed significant differences in performance on the three tests (F = 6.72, df = 2/70, $p < .01$). Multiple comparisons made by means of the Newman-Keuls test at the .05 level indicated that performance on the CQ test was significantly lower than on the DQ and Corr tests. No other differences were significant.

Discussion

The results of the analysis of covariance on final posttests indicate that institutionalized retardates, similar to educable retardates in Experiment I, are able to benefit from conservation training (see Table 3.3). No significant training effects, however, were found on the DQ posttest. Inspection of Figure 3.1 indicates that the control group showed an inordinate increase in posttest scores. It appears that the treatment given the control group may have also been beneficial in inducing conservation. Since the control Ss used the same materials as the DQ trained Ss with the exception that no reversals were made after transformations, it appears that observation of a series of transformations may induce conservation. It must be noted, however, that at the beginning of each series of the six transformations, the two quantities were in equivalent boxes/cans. Consequently, although reversals were not made, comparisons between equivalence and transformation states could have easily been made, especially when many presentations of the series were given in a session. This procedure may have allowed the child to note that, although transformations were made, the quantities were still equal in their original containers. Moreover, questioning during the control sessions focused S's attention on whether there was the same quantity after transformations. Furthermore, the control Ss received the DQ immediate posttest, as did the DQ training group, and learning may have taken place on the successive presentations of the DQ test.

It is of interest to note, however, that whatever the reason for the control Ss' improvement on the DQ posttest, no transfer occurred to Corr or CQ conservation in the control group. On the other hand, the DQ group which received training incorporating reversals and knowledge of results showed transfer to both Corr and CQ since the DQ group was significantly superior to the control on both posttests. Moreover, Corr and CQ training also showed transfer since Ss trained on one of these forms of conservation were also significantly superior to the control group on the other form.

Because Ss in this study were particularly nonverbal and the number of Ss in the control group was too small to make meaningful comparisons, no analyses were carried out to compare the number of conserving reasons given by the trained Ss with the number of conserving reasons given by the control Ss. It is believed, because of supporting evidence of this nature found in Experiment I and II, that training resulted in acquisition of conservation rather than response set. Moreover, the training task, in which Ss were given cycle two which allowed them to discover their errors, was more conducive to acquisition of conservation than to a response set to say "same."

In the present study, in contrast to previous studies (Kooistra, 1963; Goldschmid, 1967; Achenbach, 1969; Experiment I; and Experiment II), no significant relationships were found between individual comparisons, MA, CA, and IQ, and the three pretests. The previous studies mentioned above, however, have used normal or mildly retarded children as Ss. In this study, the sample consisted generally of older Ss who were afflicted with varying degrees of retardation, usually more severe than previously explored.

Again, as in Experiment I, Kooistra (1963), and Elkind (1961), discontinuous quantity appeared to have been easier than continuous quantity. The analysis of variance for repeated measures showed that Ss performed significantly higher on the DQ and Corr pretests than on the CQ pretest. On the other hand, Goldschmid (1967) has obtained results which dispute that DQ occurs before CQ. It appears that the type of materials or testing procedure used may influence the outcome of this type of investigation.

Moreover, no relationship was found between training effectiveness (see Table 3.5) and individual differences, such as IQ, MA, and CA. Furthermore, improvement did not appear to occur selectively for Ss who were partial conservers or older as had been previously found (Beilin, 1965; Strauss & Langer, 1970; Overbeck & Schwartz, 1970; Lumsden & Kling, 1969). In fact, the significant negative correlations between DQ and Corr test improvement and pretest scores indicate that Ss who were partial conservers improved less than Ss who were nonconservers. Such results may be attributable to the general effectiveness of the training methods which allowed Ss, regardless of their starting positions, to perform near maximum on the final posttest. No relationship between CQ test improvement and pretest scores was found. This latter finding may be accounted for by Ss' significantly poorer performance on this pretest and its resultant smaller variance.

In conclusion, this study gives evidence that institutionalized retardates are also able to benefit from intervention programs designed to accelerate intellectual development. Training did not specifically benefit only the Ss with higher IQs. The latter finding indicates that there may be some merit in working with moderately, as well as educably, retarded Ss in a remedial mathematical program.

Experiment IV

The Effectiveness of Conservation, Ordination, Cardination, and Classification Training Procedures with Educable and Trainable Retardates

ABSTRACT. Experiment IV was carried out to further examine the effectiveness of the DQ, O, C, and ACC training procedures. Moreover, the effectiveness of these training procedures was examined with trainable, as well as educable, Ss. The hypotheses were (a) the DQ conservation procedure accelerates conservation in educable and trainable retardates, (b) the O and C training procedures accelerate ordination and cardination in educable and trainable retardates, (c) the ACC training procedure accelerates classification in educable and trainable retardates, (d) task performance is related to MA and (e) amount of improvement is negatively related to pretest scores. The above hypotheses were generally supported by data from the educable Ss. On the other hand, data from the trainable Ss supported only hypotheses c and e.

Experiment IV was carried out to expand the findings of Experiment II and III. In Experiment II, Ss received training on discontinuous quantity (DQ) conservation, correspondence (Corr), ordination (O), cardination (C), and the additive composition of classes (ACC). Of the above five training procedures, DQ, O, and ACC appeared to be the most facilitating. The Corr training procedure did not appear to be highly effective, and the C training procedure, although somewhat facilitating, appeared doubtful in value. Consequently, Experiment IV was designed to more carefully assess the effects of training, particularly the DQ, O, C, and ACC procedures. Since Experiments I and III indicated that DQ training facilitated Corr, as well as continuous quantity (CQ) conservation, the effectiveness of the Corr procedure was not examined. Unlike Experiment II, each group received a separate training task in order that transfer effects might be assessed. Only the O and C training procedures were given to the same group.

Moreover, the results of Experiment III indicated that institutionalized retardates, who were lower in MA but higher in CA than educable retardates, were also able to benefit from training. The institutionalized retardates consisted of both educable Ss who were unable to function under normal circumstances and trainable Ss. Consequently, it was decided to examine the effects of these training procedures on trainable, as well as educable, retardates.

The specific hypotheses were as follows: (a) the DQ conservation training procedure accelerates conservation in both educable and trainable retardates, (b) the O and C training procedures accelerate ordination and cardination in educable and trainable retardates, (c) the ACC training procedure accelerates classification in educable and trainable retardates, (d) task performance is related to MA, and (e) amount of improvement after training is negatively related to pretest scores.

Experiment IVa

Experiment IVa was an attempt to assess more carefully the effects of the training procedures with educable retarded children. It was carried out to determine which individual training procedures were effective enough to expand to group training procedures.

Method

Subjects

Ss consisted of 65 educable retarded Ss, 37 males and 28 females, in the primary and intermediate special education classes at local schools in an urban setting. These Ss were selected from a total of 110 available children on the basis of performance on six Piagetian pretests. Of the 110 available children, 45 were dismissed from the study. Forty-one children were eliminated because of superior performance on the pretests, indicating that training was unnecessary. Another 4 Ss were eliminated because of inability to function in a test situation, and 1 was eliminated because he did not reach criterion before the school year ended.

The mean of the Stanford-Binet IQ scores for the 65 Ss was 67.80 (SD = 6.51); the mean CA was 10.50 (SD = 1.74); and the mean MA was 7.11 (SD = 1.41).

Procedure

The design of the study is given in Table 4.1. Ss were selected on the basis of performance on a vocabulary pretest and six Piagetian pretests--discontinuous quantity, correspondence, continuous quantity, ordination, cardination, and additive composition of classes. If S failed the vocabulary pretest, he was dismissed from further testing; if he passed it, he was given the six Piagetian pretests in two sessions. Two independent judges assigned a rating of one through five to Ss' performance on each pretest. Consequently, Ss could have a maximum total score of 30. Ss who had a total score of 23 or less on the six pretests were asked to participate further. All other Ss were dismissed from this study; however, in order to treat all available Ss equally, the

Table 4.1

Design of study showing
the four groups and their treatment.

DQ	O&C	ACC	Control
Pretests: DQ Corr CQ O C ACC	Pretests: DQ Corr CQ O C ACC	Pretests: DQ Corr CQ O C ACC	Pretests: DQ Corr CQ O C ACC
Treatment: DQ training	Treatment: O&C training	Treatment: ACC training	Treatment: Play sessions with clay and paired associate task
Immediate posttest: DQ	Immediate posttest: O C	Immediate posttest: ACC	Immediate posttest: One of the six pretests randomly selected
Final posttests: DQ Corr CQ O C ACC	Final posttests: DQ Corr CQ O C ACC	Final posttests: DQ Corr CQ O C ACC	Final posttests: DQ Corr CQ O C ACC
Delayed posttests: DQ Corr CQ O C ACC	Delayed posttests: DQ Corr CQ O C ACC	Delayed posttests: DQ Corr CQ O C ACC	Delayed posttests: DQ Corr CQ O C ACC

children who passed all tests, as well as those who failed the vocabulary pretest, were given word tasks unrelated to number readiness.

The 65 *S*s who remained in the study were assigned to four treatment groups--the DQ training group, the O&C training group which received both O and C training, the ACC training group, and the control group which received the word tasks and clay play sessions. The number of one-half hour sessions needed to reach criterion were 2.29, 1.62, 3.18 and 2.88 for the DQ, O, C, and ACC training procedures respectively. As *S*s in the training groups reached criterion, they were given an immediate posttest related to their training. *S*s in the control group, who were given approximately 2.50 one-half hour control sessions, received either the DQ, O, C, or ACC test randomly assigned in order to equate for number of test exposures. Finally, after at least one week, all *S*s received six tests identical to the pretests, as the final posttest. Moreover, six months later, the six tests were administered again as delayed posttests. All testing and training sessions were individually administered by six *E*s using a standardized procedure.

Pretests

Vocabulary pretest. The vocabulary test, identical to that given in Experiment II (see Appendix B) was given to assess whether *S* understood the words used on the six Piagetian tests. The words were "same," "more," "smallest," "biggest," "next smallest," "next biggest," "in front of," "between," "first," "last," "second," "third," etc. *S*s who failed this pretest were not tested further.

Discontinuous quantity (DQ) pretest. The DQ pretest was identical to that given in Experiment I, II, and III. It has been described in the above experiments and the original version is presented in Appendix C so only a brief description will be given here. At the outset, after *S* agreed that he and *E* had an equal number of beads in their glass containers, *S*'s beads were transferred to a succession of different shaped containers and combination of containers. Following each transformation, *S* was asked whether he had the same number of beads as *E*, whether necklaces made from *E*'s and *S*'s beads would be equal in length, and to explain each answer.

Correspondence (Corr) pretest. The Corr pretest was identical to that used in Experiments II and III and is described in the above studies as well as in Appendix E. Consequently, only a brief description will be included here. *E*, with his chips, constructed three different models in succession. After *E* completed each model, he asked *S* to construct the same figure with the same number of chips. *E* then spread the chips in his model and asked *S* if they still had the same number and to explain his answer. The same procedure was repeated for each model with *S* using sticks, instead of chips.

Continuous quantity (CQ) pretest. The CQ pretest was identical to the one used in Experiments I, II, and III. A copy of the original version is contained in Appendix F. E and S each started with a ball of clay which S believed equal. Then S's ball was successively transformed into six different shapes. Following each transformation, S was asked whether E's and S's amounts of clay were the same and to explain his answer.

Ordination (O) pretest. The O pretest was identical to the one described in Experiment II and in Appendix G. In brief, S was presented with eight sticks differing in height and asked to construct a stairway. Next, he was presented with seven sticks which fit between the eight sticks and was asked to make a larger stairway. E then constructed another stairway with thinner sticks above S's stairway and, while pointing successively to various steps on the new stairway, asked S to find the same steps on his stairway. In addition, S was asked to find selected steps both with E's stairway in reverse order and S's stairway in random order.

Cardination (C) pretest. The C pretest has been previously described in Experiment II and Appendix H. E presented S with ten blocks from 1 x 1 x 1 to 1 x 1 x 10 inches in size. After explaining the special properties of the blocks, E asked S how many blocks like the first could be made from other blocks while in a stairway and then in random order.

Additive composition of classes (ACC) pretest. The ACC pretest was similar to that used in Experiment II, but since it was believed that some of the trainable Ss might have difficulty with felt squares, the materials were changed from felt squares to drawings of boys and girls. A complete version of this test is included in Appendix J. E presented S with a drawing of two girls and five boys and asked S if both the boys and girls were children. After S replied positively, E asked whether there were more boys or more children and whether a row made of children or one made of boys would be longer. E then added a drawing of 10 girls, stating that there were now more girls than boys, and asked S whether there were more girls or more children. Next, E removed the ten extra girls and asked whether there were more children or more boys. E further questioned whether, if all the children were put into a school, there would be any boys or girls left outside. Furthermore, E asked whether there would be any children left outside if all the boys were put in the school. Finally, E asked again whether both boys and girls were children, whether there were more children or more boys, and whether a row of children or a row of boys would be longer.

Treatment

The Ss were randomly assigned to one of four treatment groups. The first group received DQ training, the second received both O and C training, the third received ACC training, and the fourth served as a control.

Discontinuous quantity (DQ) training group. The DQ training procedure has been described elsewhere (see Experiments I, II, III, and Appendix K) and will only be briefly described here. The materials consisted of boxes and erasers and sticks and cans. E began the session by having S establish the equivalence of two quantities of erasers/sticks in two equal boxes/cans. Then one quantity was transformed by putting it into various sized boxes/cans. After each transformation, S was told to check the correctness of his response by reversing the transformation back to its original state (container). If S failed to conserve on any particular transform, it was repeated. On the second time, however, if S maintained that the quantities were unequal, he was asked to make them the same by adding or taking away some amount. Consequently, upon reversal to the original container, he was shown that the quantities were now unequal by the amount he added or took away. The latter served to heighten the conflict which S was experiencing. After S reached criterion, i.e., S made no errors on the successive transformations, E administered a DQ immediate posttest, identical to the DQ pretest.

Ordination and Cardination (O&C) training group. The O and C training procedures were identical to the ones given in Experiment II and are described in detail in Appendices O and P.

The materials used in the O training procedure consisted of one-eyed wooden figures called Zerbils, varying in height, and the doors to their invisible homes, also varying in height. S was told a story to the effect that the Zerbils must walk in a straight line from smallest to tallest so that all Zerbils can see to avoid danger. S was asked to put the Zerbils in a line from smallest to tallest so that each could see over the head of the one in front. Next, S was presented with the doors and asked to line up their doors so that each Zerbil could quickly find his home. Finally, S was asked to find the doors of certain Zerbils, first with the Zerbils in reverse order, and then in random order.

The materials for the C training procedure consisted of 15 wooden blocks, each one cubic inch, and 10 felt strips, 1 x 1 to 1 x 10 inches, along with some extra felt pieces, 1 x 1 and 1 x 3 inches. In the first part, S was asked to make a stairway of five steps with the wooden blocks. E then asked how many blocks must be added or taken away to make two steps the same. In the second part, S made a stairway with six strips of felt (1 x 1 to 1 x 6 inches) and was asked how many pieces like the first one could be made from the other steps. S was also asked how many pieces like the third step could be made from the sixth step. In addition, S was shown that three steps like the first could be made from the third step and two steps like the third could be made of the sixth step; therefore, three times two equals six. The remaining four steps (1 x 7 to 1 x 10 inches) were added to the stairway, and S was asked how many pieces like the first step could be made from the other steps, first as a stairway and then in random order. After S reached criterion on both O and C training, he was given both O and C immediate posttests which were identical to the O and C pretests.

Additive composition of classes (ACC) training group. The ACC training procedure was identical to the one used in Experiment II and is included in Appendix Q. In the first part, S was presented two round yellow beads, eight round green beads, and five square blue beads, all of wood. First, S was asked if there were more green beads or more round beads. All answers were checked and corrected if wrong. Moreover, S was asked what color a necklace of round beads would be and whether a necklace of round beads or one of green beads would be longer. The round beads were then changed so that there were two round green and eight round yellow beads. The above questions were repeated, this time comparing the yellow, instead of green, beads and round beads. Finally, S was asked to concentrate on the number of round and wooden beads, and the above questions were repeated comparing round and wooden beads.

In the second part, S was presented with two blue and eight orange wooden rhythm sticks and was asked whether there were more orange or wooden sticks. All S's answers were checked and corrected. Next, the number of sticks were altered so that there were now two orange and eight blue sticks, and S was asked whether there were more blue or more wooden sticks. Finally, four blue wooden blocks were added, and S was asked to compare the number of blue things with the number of wooden things. After S reached criterion on ACC training, S received an ACC immediate posttest identical to the ACC pretest.

Control group. The control Ss received a paired associate learning task which lasted approximately one-half hour. To fill time in the other sessions, S was given clay and asked to make whatever he wished. The control Ss were given 2.5 one-half hour sessions which was approximately the average number of sessions needed by the experimental Ss, regardless of training group, to reach criterion. On the last session, control *S*s were given an immediate posttest, identical to one of the six pretests, randomly assigned, in order to control for number of test exposures.

Final posttests. Approximately one week after the immediate posttests were given, *S*s received six final posttests, identical to the six pretests.

Delayed posttests. Approximately six months after *S*s received the final posttests, six delayed posttests were administered. Again, these posttests were identical to the six pretests, as well as to the final posttests. The six-month delay occurred during the summer vacation. Consequently, little teaching related to the posttests was received by *S*s, thereby allowing maximum decrease in performance to occur.

Results

Two judges independently scored 24 *S*s on the six pretests. Performance on each pretest was given a score from one to five, similar to Piaget's three stages but also including two transitional steps, to facilitate scoring between stages. Spearman rank correlation coefficients between the two judges were .94, .91, .98, .82, .89, and .90 for the DQ, Corr, CQ, O, C, and ACC pretests respectively. One judge then scored the remaining *S*s' pretests.

The results of both the pre- and posttests were reported in percentages as number correct out of total possible correct. Figure 4.1 illustrates the pre- and final posttest percentages for the four groups on the three conservation tests--DQ, Corr, and CQ. Figure 4.2 illustrates the pre- and final posttests percentages on the O, C, and ACC tests.

Performance on the final posttests was compared with performance on the immediate posttests for the trained groups to determine whether there was a loss in the one-week interval. No significant differences ($p > .05$) were found between performances on the two posttests ($t = .72$, $df = 16$; $t = 1.83$, $df = 15$; $t = .59$, $df = 15$; and $t = .33$, $df = 15$ for the DQ, O, C, and ACC posttests respectively).

An arcsin transformation of the percentage scores was made prior to subjecting the data to analyses. Six analyses of covariance were computed, one on the data from each of the six Piagetian tests. Significant differences were found among the four groups on the DQ, CQ, O, C, and ACC posttests ($F = 3.61$, $df = 3/60$, $p < .05$; $F = 1.70$, $df = 3/60$, $p > .05$; $F = 3.49$, $df = 3/60$, $p < .05$; $F = 4.78$, $df = 3/60$, $p < .01$; $F = 5.23$, $df = 3/60$, $p < .01$; and $F = 10.17$, $df = 3/60$, $p < .01$ for the DQ, Corr, CQ, O, C, and ACC posttests respectively.

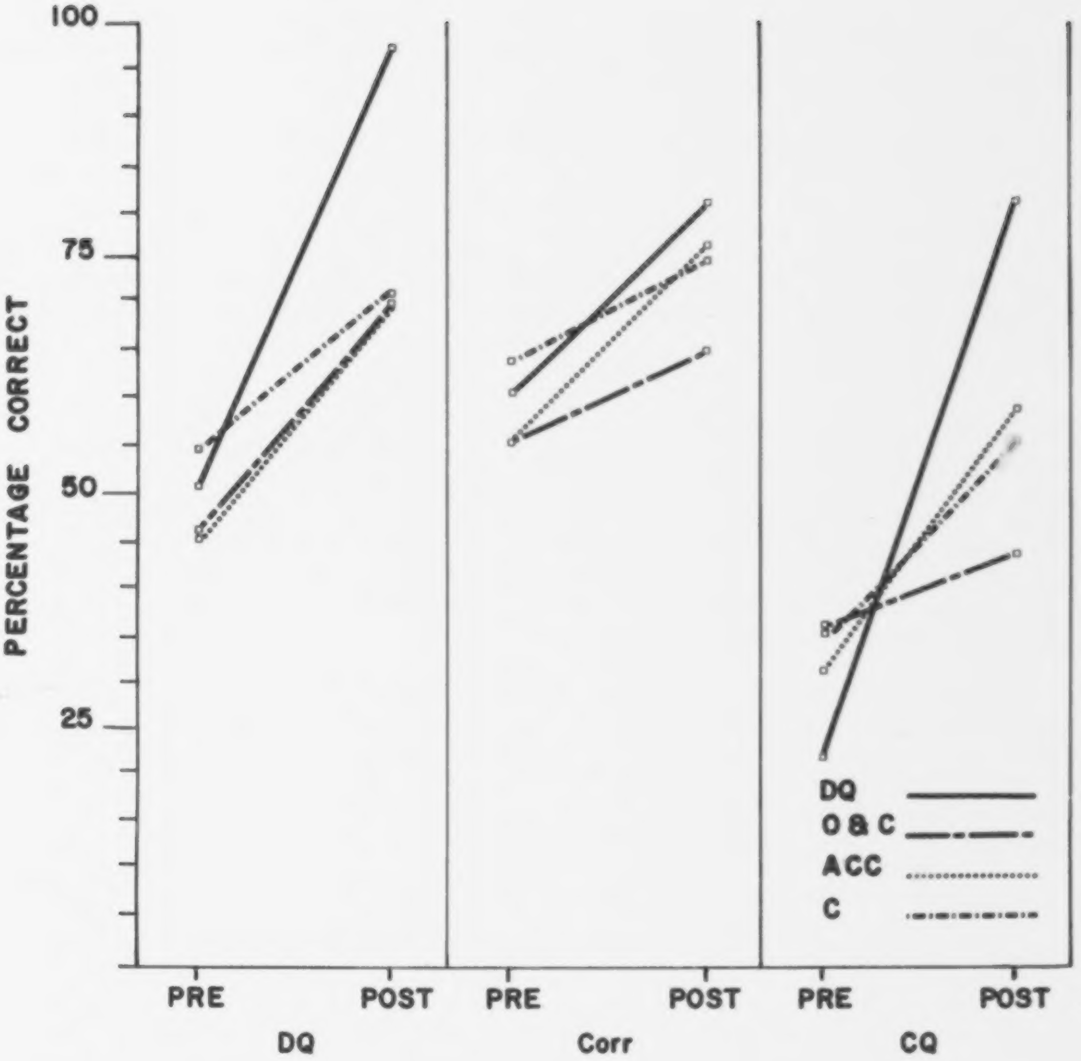

Figure 4.1 Performance of the four educable treatment groups on the DQ, Corr, and CQ pre- and posttests.

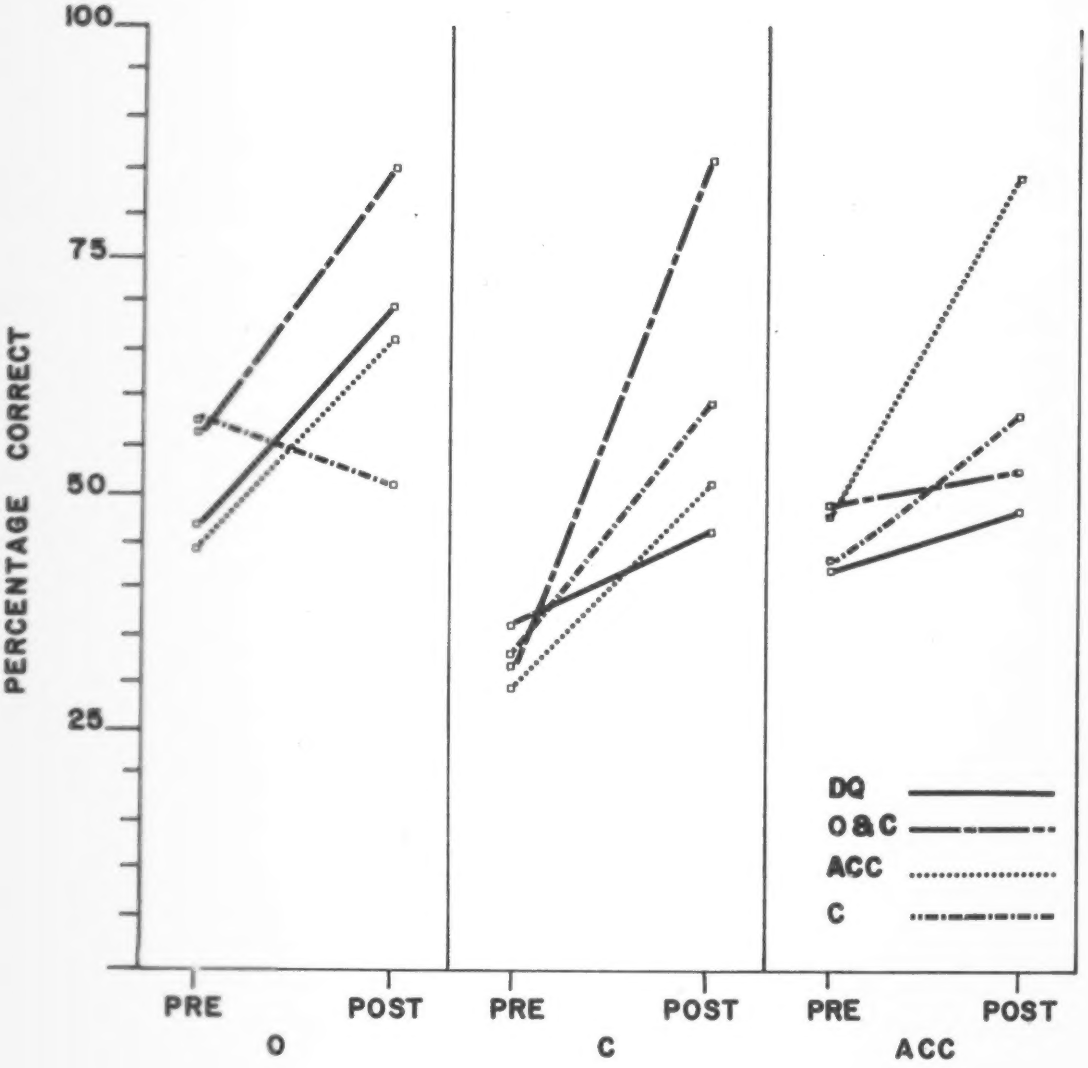

Figure 4.2 Performance of the four educable treatment groups on the O, C, and ACC pre- and posttests.

Multiple comparisons (see Winer, p. 592) were made between the adjusted posttest means for the tests on which the groups differed. Table 4.2 shows the groups which differed significantly. On the DQ posttest, the DQ training group was significantly superior to the other three groups.

Table 4.2

Multiple comparisons
between the adjusted posttest means.

Post-tests	Group	DQ	O&C	ACC	Control
DQ	DQ		*[1]	*	*
	O&C				
	ACC				
	Control				
CQ	DQ		*		*
	O&C				
	ACC				
	Control				
O	DQ				*
	O&C				*
	ACC				*
	Control				
C	DQ		*		
	O&C			*	*
	ACC				
	Control				
ACC	DQ			*	
	O&C			*	
	ACC				*
	Control				

[1] The groups differed significantly beyond the .05 level.

On the CQ posttest, the DQ group was significantly superior to the O&C and control groups. On the O posttest, all three training groups were significantly superior to the control group, whereas on the C posttest, the O&C group was significantly superior to the other three groups. Furthermore, on the ACC posttest, the ACC group was significantly superior to the other three groups.

In order to examine the reliability of the six Piagetian tests, Pearson product-moment correlation coefficients were computed between the pre- and posttests for the 16 control Ss. The correlation coefficients were .64, .77, .39, .47, .40, and .55 for the DQ, Corr, CQ, O, C, and ACC tests respectively.

Moreover, the relationships between tests were examined by means of the Pearson product-moment correlation coefficients between the pretests for all Ss. Table 4.3 shows the correlation coefficients between tests. The three conservation pretests, DQ, Corr, and CQ, were found to be positively interrelated. Moreover, Corr was positively related to O and C, and CQ was negatively related to ACC. Furthermore, O and C were positively related. No other significant relationships were found.

Table 4.3

Relationships among the six pretests.

Pretest	DQ	Corr	CQ	O	C	ACC
DQ		.49**	.33**	.24	.14	-.14
Corr			.49**	.42**	.27*	.16
CQ				.12	.10	-.30*
O					.31*	.21
C						.18
ACC						

** $p < .01$, df = 63

* $p < .05$, df = 63

Pearson product-moment correlation coefficients were also computed between the pretests and individual differences, such as IQ, MA, and CA. Table 4.4 shows the correlation

Table 4.4

Relationships between
pretest scores and IQ, MA, and CA.

	Pretests					
	DQ	Corr	CQ	O	C	ACC
IQ	.02	.14	.06	.20	.22	.08
MA	.27*	.39**	.13	.48**	.28*	.06
CA	.30*	.38**	.22	.42**	.19	.02

* $p < .05$, $df = 63$

** $p < .01$, $df = 63$

coefficients between these variables. DQ, Corr, and O pretests were found to be significantly related to both MA and CA. Furthermore, the C pretest was found to be related to MA only. No other significant relationships were found.

In addition, the relationships between training effectiveness as measured by the amount of improvement from pre- to posttest and individual differences, such as IQ, MA, CA, and pretest scores, were also examined by means of the Pearson product-moment correlation coefficients. Table 4.5 shows the correlation coefficients between these variables.

Table 4.5

Relationships between test improvement from pre- to posttest and individual differences for the Ss who received training.

Test Improvement	IQ	MA	CA	Pretest Score
DQ (n = 17)	.30	-.20	-.29	-.97**
Corr (n = 17)	-.19	-.25	-.15	-.66**
CQ (n = 17)	.12	-.06	-.09	-.57*
O (n = 16)	.02	-.25	-.33	-.86**
C (n = 16)	.00	.01	.05	-.94**
ACC (n = 16)	.46	.29	.06	-.45

* $p < .05$

** $p < .01$

No significant relationships were found between test improvement and IQ, MA, or CA. Significant negative correlations, however, were found between test improvement and pretest score on DQ, Corr, CQ, O, and C, although no relationship was found between test improvement and pretest score on ACC.

A repeated measures analysis of variance was performed on the six pretest scores from each S to determine which was the easiest of the six tests. The means for the 65 Ss were .49, .58, .31, .52, .33, and .45 for the DQ, Corr, CQ, O, C, and ACC pretests respectively. The analysis showed a significant difference among groups ($F = 9.40$, $df = 5/320$, $p < .01$). Multiple comparisons (see Table 4.6) by means of the Newman-Keuls test showed that performances on the DQ, Corr, O, and ACC pretests were superior to those on both the CQ and C posttests ($p < .05$). All other differences were nonsignificant.

Table 4.6

Significant differences between performance on the six pretests.

Test		Corr	O	DQ	ACC	C	CQ
	Mean	.58	.52	.49	.45	.33	.31
Corr	.58					*	*
O	.52					*	*
DQ	.49					*	*
ACC	.45					*	*
C	.33						
CQ	.31						

* $p < .05$

Performance on the delayed posttests was compared with performance on the final posttests by means of the t test in order to determine whether there was a significant decrease in Ss' performance after a six-month delay. Table 4.7 shows the mean percentage correct for Ss who received training related to the specific tests. A significant difference ($t = 2.45$, $df = 7$, $p < .05$) was found between performance on the DQ final and delayed posttests for Ss who received DQ training. No significant difference was found between performance on the O final and delayed posttests ($t = .58$, $df = 6$, $p > .05$) for the O&C group which received O training. Moreover, no significant difference was found between the

Table 4.7

Mean percentage correct on the final and delayed posttests for *S*s who had received training related to the tests.

	Posttest	
	Final	Delayed
DQ	.94	.62
O	.72	.78
C	.76	.87
ACC	.82	.76

C final and delayed posttests ($t = 2.07$, $df = 6$, $p > .05$) for the O&C group which had also received C training. Finally, no significant difference was found between the ACC final and delayed posttests ($t = .81$, $df = 11$, $p > .05$) for *S*s trained on ACC.

Experiment IVb

Experiment IVb consists of a replication of Experiment IVa with trainable, instead of educable, retarded *S*s. The purpose of this study was to determine the effectiveness of the above training procedures using *S*s who were older and had lower IQs. This study, except for type of *S*s, was identical in every respect to Experiment IVa.

Method

Subjects

*S*s were 28 trainable retarded *S*s, 20 males and 8 females from a local special school, who were selected on the basis of performance on a vocabulary and six Piagetian pretests. Twenty-five *S*s, from a total of 53, did not complete the study; 10 were nontestable, 7 moved during the course of the study, 3 were unable to remain in a training situation, and 5 showed superior performance on all six of the Piagetian pretests.

Intelligence scores, mental ages, and chronological ages were available for 27 of the 28 *S*s. The mean of the Stanford Binet IQ scores was 50.96 (SD = 5.52); the mean MA was 7.65 (SD = 1.57); and the mean CA was 15.07 (SD = 2.84).

Procedure

Table 4.1 shows the design of this study which was identical to Experiment IVa. All *S*s received a vocabulary and six Piagetian pretests--DQ, Corr, CQ, O, C, and ACC. A description of these pretests has been included in Experiment IVa, and, consequently, is not repeated here. Each *S*'s performance was rated from 1 to 5 on each of the six pretests. If *S*'s combined rating for the six pretests was 23 or less, he was retained as a participant in the study and assigned to one of the four treatments. If his rating was 24 or above, *S* was dismissed from further participation; five *S*s were dismissed for this reason.

The 28 remaining *S*s were randomly assigned to the DQ training group, the O&C training group, the ACC training group, or the control group. The treatments given these groups have been described in Experiment IVa and, consequently, are not described here. The trained *S*s needed 2.50, 2.71, 3.71, and 2.86 one-half hour sessions to reach criterion on the DQ, O, C, and ACC training procedures. Upon reaching criterion, experimental *S*s were given immediate posttests, identical to the pretests, related to the type of training received. The control group received approximately 3 one-half hour sessions which was the average number of sessions all experimental *S*s received. On the last control session, these *S*s were given either the DQ, O, C, or ACC test randomly assigned in order to equate the experimental and control groups in number of tests received.

One week later, all *S*s were given six final posttests, also identical to the pretests. Approximately six months after the final posttests, the tests were readministered as delayed posttests. *S*s were individually tested and trained by six *E*s who alternated as testers and recorders in a standardized procedure.

Results

The amount correct on each test was scored as the percentage of total possible correct. Figure 4.3 illustrates the performance of the trainable *S*s on the DQ, Corr, and CQ pre- and final posttests. Figure 4.4 illustrates their performance on the O, C, and ACC pre- and posttests.

The t test was used to compare performances on the immediate and final posttests of *S*s who had been trained. No significant differences ($p > .05$) were found between these two posttests ($t = 1.00$, $df = 7$; $t = 1.26$, $df = 6$; $t = 1.62$, $df = 6$; $t = .97$, $df = 6$ for the DQ, O, C, and ACC tests respectively), although there was a one-week interval between the two posttests.

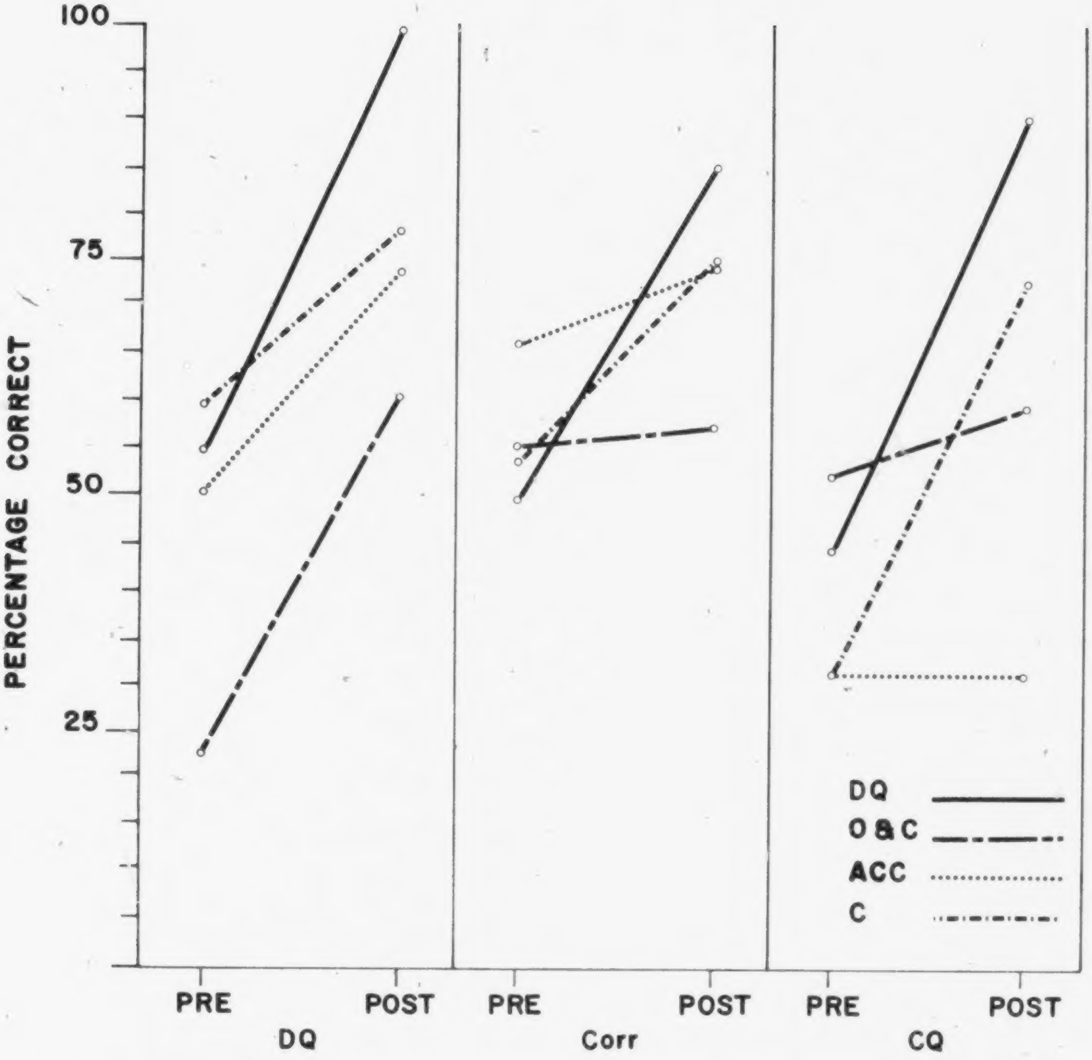

Figure 4.3 Performance of the four trainable treatment groups on the DQ, Corr, and CQ pre- and posttests.

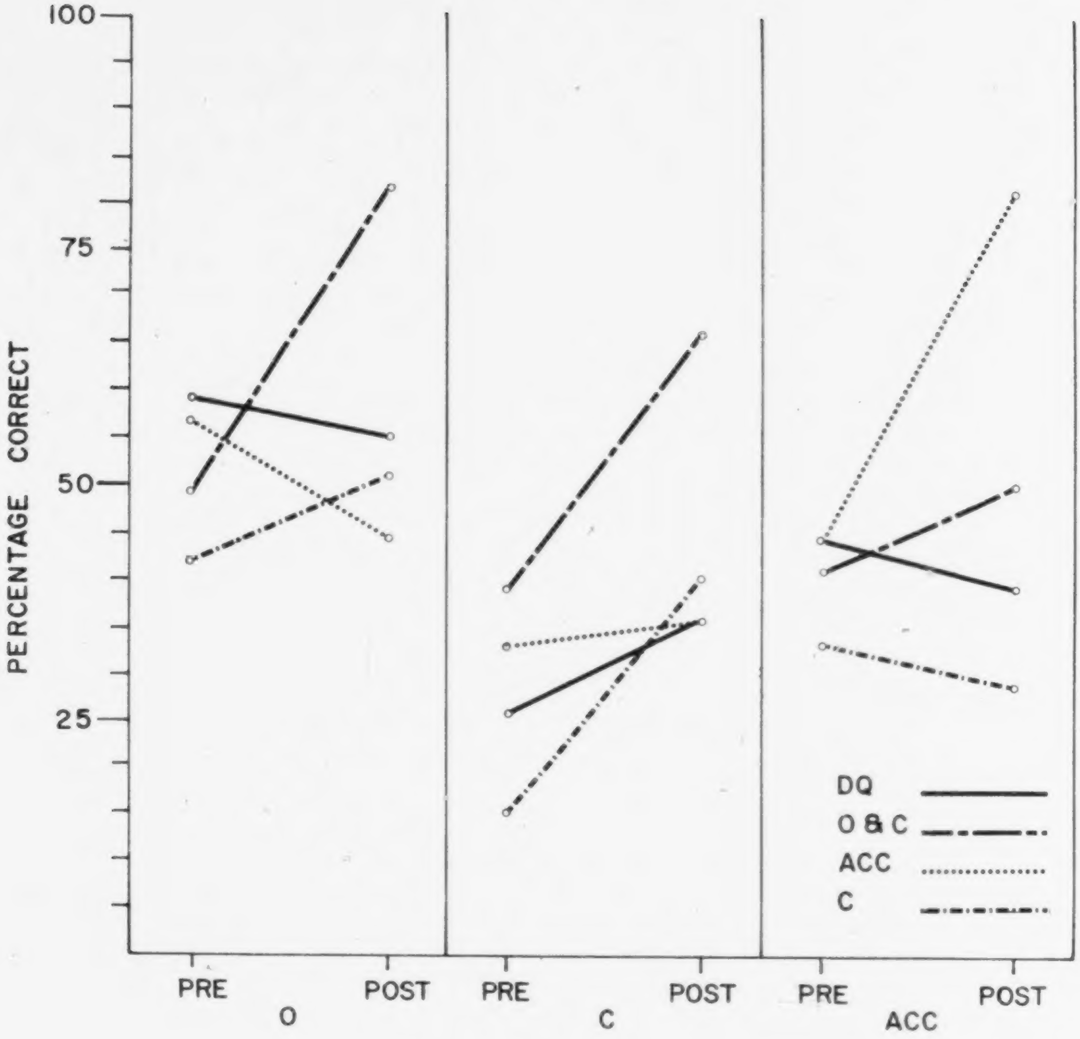

Figure 4.4 Performance of the four trainable treatment groups on the O, C, and ACC pre- and posttests.

Since the data were in the form of percentages, an arcsin transformation of scores was made. Six separate analyses of covariance were computed, one for each of the six tests. These analyses showed significant differences among groups on the Corr, CQ, and ACC posttests ($F = 1.36$, $df = 3/23$, $p > .05$; $F = 4.14$, $df = 3/26$, $p < .05$; $F = 3.41$, $df = 3/26$, $p < .05$; $F = 2.13$, $df = 3/23$, $p > .05$; $F = 1.91$, $df = 3/23$, $p > .05$; $F = 7.56$, $df = 3/23$, $p < .01$ for IQ, Corr, CQ, O, C, and ACC respectively). Multiple comparisons between groups on the Corr, CQ, and ACC adjusted posttest means were made. Table 4.8 shows the groups which differed

Table 4.8

Multiple comparisons
between adjusted posttest means.

	Corr Posttest				CQ Posttest				ACC Posttest			
Groups	DQ	O&C	ACC	C	DQ	O&C	ACC	C	DQ	O&C	ACC	C
DQ		*[1]					*				*	
O&C											*	
ACC								*			*	
C												

[1] The groups differed significantly beyond the .05 level.

on these three posttests at the .05 level. On the Corr posttest, the DQ group was superior to the O&C group. On the CQ posttest, both the DQ and C groups were superior to the ACC group. Moreover, on the ACC posttest, the ACC group was superior to all other groups.

The relationships among the six tests were examined by means of Pearson product-moment correlations between pretest scores of all Ss. Table 4.9 shows the correlation coefficients between the six pretests. The three conservation tests, DQ, Corr, and CQ, were positively interrelated. On the other hand, DQ and C were negatively related. No significant relationships were found between the other pretests.

The relationships between pretest performances and individual differences, IQ, MA, and CA, were also examined by means of Pearson product-moment correlations. Table 4.10 shows the correlation coefficients between pretest scores and individual differences. No significant relationships

Table 4.9

Relationships between the six Piagetian pretests.

Pre-tests	DQ	Corr	CQ	O	C	ACC
DQ		.53**	.60**	.19	-.44*	.05
Corr			.42*	.28	-.25	.00
CQ				.27	-.30	-.15
O					.10	-.21
C						.09
ACC						

** $p < .01$, df = 26

* $p < .05$, df = 26

Table 4.10

Relationships between
the six pretests and IQ, MA, and CA

	DQ	Corr	CQ	O	C	ACC
IQ	-.19	.17	-.02	.18	.29	-.14
MA	-.14	.09	.17	.25	.38	.04
CA	-.05	.00	.18	.16	.22	.14

were found, although the correlation coefficient, .38, between MA and the C pretest approached significance at the .05 level (for df = 25 critical value of r = .381).

Moreover, the relationships between training effectiveness, measured by amount of test improvement, and individual difference, such as IQ, MA, CA, and pretest scores, were also determined by means of Pearson product-moment correlation coefficients. Table 4.11 shows the correlation coefficients between these variables. No significant relationships were found between test improvement and IQ, MA, or CA. On the other hand, significant negative relationships were found between test improvement and pretest scores on DQ, Corr, CQ, and O.

Table 4.11

Relationships between test improvement from pre- to posttest and individual differences for the Ss who received training.

Test Improvement	IQ	MA	CA	Pretest Score
DQ (n = 9)	.57	-.77	-.23	-.99**
Corr (n = 9)	.35	.35	.29	-.75*
CQ (n = 9)	.49	.08	-.16	-.82**
O (n = 7)	-.06	-.58	-.53	-.79*
C (n = 7)	-.29	-.61	-.42	-.66
ACC (n = 6)	.04	.54	.07	-.70

** $p < .01$

* $p < .05$

An analysis of variance of repeated measures was computed to determine which of the six pretests was easier. The means of all Ss' scores on the six pretests were .46, .55, .40, .52, .25, and .41 for the DQ, Corr, CQ, O, C, and ACC pretests respectively. Prior to analysis, an arcsin transformation of the scores reported in percentages was made. The analysis of variance showed that the tests differed in difficulty (F = 3.61, df = 5/135, $p < .01$). Multiple comparison by means of the Newman-Keuls method at the .05 level indicated that the DQ, Corr, and O pretests were significantly easier than the C pretest (see Table 4.12). All other differences were non-significant.

Table 4.12

Significant differences between performance on the six pretests.

Test		Corr	O	DQ	ACC	CQ	C
	Mean	.55	.52	.46	.41	.40	.25
Corr	.55						*
O	.52						*
DQ	.46						*
ACC	.41						
CQ	.40						
C	.25						

*$p < .05$

The results of the delayed posttests were not analyzed for the trainable Ss. Data from too few Ss were available. For example, in the DQ training group, delayed posttest data from only three Ss were available. The remaining training groups had delayed posttest data from only five Ss. Consequently, it was not believed meaningful to analyze these results. Moreover, the test-retest reliability of the six Piagetian tests was not determined, since there were too few Ss in the control group (n = 6).

Discussion

On the whole, the training procedures were more successful with educable, than trainable, retardates. For the educable Ss, the DQ, O, C, and ACC training procedures were highly effective; only performance on the Corr posttest showed no facilitation. Moreover, the DQ and ACC training procedures showed transfer to performance on posttests other than the ones directly related to them. The DQ training procedure facilitated CQ, as well as DQ, and the DQ and ACC training procedures both facilitated performance on the O posttest. In contrast to the findings of Inhelder & Sinclair (1969), ACC training effects did not transfer to performance on any of the three conservation posttests.

The effectiveness of the training procedures is in agreement with results obtained in Experiment II, with the exception that, in the present study, the C training procedure was more effective. The results of Experiment II indicated that the C training procedure was ineffective with Ss who were intermediate in performance. Since the criterion used for the selection of Ss in the present study was not particularly stringent, many Ss who were intermediate in performance participated; yet, C training appeared highly effective. Furthermore, for the educable Ss, no decrement was found between the immediate posttests and the final posttests given one week later. In addition, performances on the final and delayed posttest did not generally show a decrement during a six month delay. Only on the DQ posttest, was a significant difference found, indicating that the DQ trained Ss did not retain what they had learned. Ss in the O&C group, however, showed no decrements on either the O or C posttests. In fact, performance on both O and C showed a slight rise from the final to the delayed posttests. Moreover, no decrement was found in performance on the ACC posttests.

For the trainable Ss, the DQ, O, and C training procedures did not appear effective. Although, significant differences were found among the Corr, CQ, and ACC posttest adjusted means, only the differences on the ACC posttest were meaningful. On the Corr and CQ posttests, none of the trained groups was superior to the control group. Consequently, only the ACC training procedure was effective as hypothesized since the ACC group was superior to all other groups, including the control group. The lack of positive results on the other posttests may reflect the greater variance and smaller numbers within groups.

In the present study, as in Experiment II, the pretests were found to differ in difficulty. For both educable and trainable Ss, the C pretest appeared quite difficult; performance on the DQ, Corr, and O pretest was superior to that on the C pretest. The educable Ss found CQ the most difficult with C a close second. On the other hand, the trainable Ss found the C pretest most difficult, with CQ second, but not close to C in difficulty. These results are not in agreement with those of Experiment II. Comparisons between the present study and Experiment II must be made with caution, however, since both the ACC test and the criterion for selection of Ss differed. In Experiment II, ignoring the position of the ACC pretest which was the most difficult, the DQ and Corr pretests were significantly easier than both the O and C. In fact, the O pretest was more difficult than any of the other pretests, except ACC.

The reliability of the six pretests, examined by comparing the educable control Ss' pretest and posttest scores, showed moderate correlations for the DQ, Corr, O, and ACC tests with lower correlations for the CQ and C tests. The latter appear to reflect the greater difficulty on these tests accompanied by a more restricted range in scores.

The correlation coefficient between the six different pretests showed significant relationships among the three conservation pretests, DQ, Corr, and CQ, for both educable and trainable Ss. For the educable Ss, moreover, positive relationships were found between Corr and O, Corr and C, O and C, and a negative relationship was found between CQ and ACC. The relationships in this study, however, were not as strong as those in Experiment II, and fewer pretests were related. For the trainable Ss, moreover, even fewer relationships were found.

In the present study as in previous ones, MA and performance on the pretests, except CQ and ACC, were related for the educable Ss. Moreover, relationships between CA and the DQ, Corr, and O pretests were found for the educable Ss. These results are similar to those obtained in Experiment II; however, in the present study, fewer and less strong relationships were found. Again, it must be noted that the criterion for selection of Ss for the two studies were different. It is likely that the selection of Ss in Experiment II led to greater variability of performance on the pretest scores. Finally, for the trainable Ss, no relationships were found between pretest scores and individual differences.

Furthermore, as in Experiment II, no relationships were found between the amount of test improvement after training and IQ, MA, or CA. For the educable Ss, again similar to Experiment II, there were negative relationships between test improvement and pretest scores, except for ACC. These results, as before, indicate that the success of the training procedures is not dependent upon S's age, intelligence, or starting point. Rather, the procedures are generally successful for educable Ss, regardless of individual differences. Similar results were obtained with trainable Ss; no relationships were found between test improvement and IQ, MA, or CA, but negative relationships were found between test improvement and the DQ, Corr, CQ, and O pretest scores.

In summary, the results of this study with educable Ss support hypotheses a, b, and c that the DQ, O, C, and ACC training procedures are effective. For the trainable Ss, however, only hypothesis e, that the ACC training procedure accelerates classification, was supported. Moreover, for the educable Ss, hypothesis d, that test performance was related to MA, was supported, except for the CQ and ACC tests. For the trainable Ss, however, no relationship was found between test performance and MA. Finally, hypothesis e, that test improvement was negatively related to pretest score, was supported by the results with educable Ss, except for ACC, and with trainable Ss, except for C and ACC. In conclusion, positive results were generally obtained with educable Ss but not with trainable Ss.

Experiment V

The use of group procedures in conservation, ordination, cardination, and classification training of educable retardates.

ABSTRACT. The individualized discontinuous quantity (DQ), ordination (O), cardination (C), and additive composition of classes (ACC) training procedures which had been successful in Experiment IV were modified so that they could be administered to groups of Ss. Educable Ss were randomly assigned to an experimental condition in which they received training on DQ, O, C, and ACC as groups within their classrooms, or to a control group. The hypotheses were (a) the DQ group training procedure is effective in accelerating conservation, (b) the O group training procedure is effective in accelerating ordination, (c) the C group training procedure is effective in accelerating cardination, (d) the ACC group training procedure is effective in accelerating classification, (e) performance on the pretests is related to MA, and (f) the effectiveness of training is negatively related to pretest scores. The results showed that the experimental group was superior to the control group on the CQ, O, and C posttest, thus supporting hypotheses a, b, and c. The ACC group training procedure did not appear to be effective. Moreover, performance on only two of the six pretests, Corr and O, were related to MA, thus lending little support to hypothesis e. Finally, test improvement generally was negatively related to pretest score, providing evidence for hypothesis f.

Experiment IV showed that the discontinuous quantity (DQ), ordination (O), classification (C), and additive composition of classes (ACC) training procedures were highly effective for educable Ss. These training procedures were individually administered to each S in standardized sessions. Unlike Experiment II in which the C training procedure appeared doubtful in value, Experiment IV indicated that the C training procedure, as well as the other training procedures, was highly successful. These results were encouraging particularly for the development of group training procedures. Consequently, it was decided to devise group administrative procedures for DQ, O, C, and ACC training.

The group procedures were developed mainly because comments from several teachers indicated that the individualized training procedures might not be practical. These teachers felt that, although success of individualized training procedures was interesting, they themselves were unable to devote the amount of time needed for each training session with a single individual. Therefore, in order to adapt the procedures to a busy teacher's schedule, the training procedures were modified so that several children could be trained simultaneously. Moreover, it was decided, in order to maintain the attention of all children in the group, to rotate the questioning and material manipulations so that each child had his turn. It was believed that not only would the children learn through their own turn with the materials, but they would learn through observation of the other children's behavior in the training situation.

Furthermore, teachers, instead of research assistants, were asked to play the role of the experimenters, particularly since the comments of teachers as training progressed were believed valuable for further refinements in the group training procedures. Moreover, it was of interest to see how the procedures would adapt to a more natural setting in a classroom, rather than an ideal one-to-one session in an experimental room. Furthermore, if the training procedures were successful with teachers, as well as research assistants who were well rehearsed in their administration, the training procedures could be considered highly effective indeed.

The hypotheses tested were (a) the DQ group training procedure is effective in accelerating conservation, (b) the O group training procedure is effective in accelerating ordination, (c) the C group training procedure is effective in accelerating cardination, (d) the ACC group training procedure is effective in accelerating classification, (e) performance on the pretests is related to MA, and (f) the effectiveness of training is negatively related to pretest scores.

Method

Subjects

Ss consisted of 38 educable retarded children (16 females and 22 males) from primary and intermediate special education classes in four urban schools. They were selected from a total sample of 109 testable Ss (5 were nontestable) on the basis of performance on six Piagetian pretests--discontinuous quantity (DQ) conservation, correspondence (Corr), continuous quantity (CQ) conservation, ordination (O), cardination (C), and additive composition of classes (ACC).

Children were rated according to the three stages of development described by Piaget (1952), using a five point scale to account for transitions between stages. Children were eliminated from further participation in the study if, on the five point scale, they scored above three on more than three of the six pretests. Sixty-eight Ss were eliminated. The remaining 41 were randomly assigned to an experimental or control condition. Three of the Ss originally assigned as experimental Ss were later dropped from the study--two for disruptive behavior in the experimental situation and one for inability to follow even the simplest instructions--leaving a total of 38 Ss.

Five Ss, because they did well on the three conservation pretests, were not assigned to treatments until after DQ training had taken place. Therefore, before the five Ss were added, 17 Ss received DQ training in the experimental condition while 16 Ss served as controls. With the five additional Ss, 19 Ss received O, C, and ACC training in the experimental condition and 19 Ss served as controls. The mean of the Stanford-Binet IQ scores for 36 Ss (2 Ss' scores were unattainable) was 66.25 (SD = 5.94), the mean of their mental ages (MA) was 6.52 (SD = .80), and the mean chronological age (CA) was 9.85 (SD = 1.24).

Procedure

All Ss received a vocabulary and six Piagetian pretests. Those who passed the vocabulary test and were judged to be below stage four on at least three of the pretests were randomly selected to be in the experimental or control condition.

The experimental Ss were run as groups within their own classroom; five separate groups were formed. Consequently, the experimental condition consisted of one group of 2 Ss, one of 3 Ss, and three of 4 Ss for a total of 17 experimental Ss who received DQ training. For O, C, and ACC training, however, two Ss were added. The experimental condition then consisted of two groups of 3 Ss, two groups of 4 Ss, and one group of 5 Ss for a total of 19 experimental Ss.

The individual training methods previously used in Experiment IV were modified for group usage in the present study. One modification included requiring Ss to take turns, instead of training one S to criterion. In all classrooms except one, training was carried out by Ss' usual classroom teacher while E scored the Ss' responses. In the excepted classroom, due to the teacher's unwillingness to give time to this study, E conducted the training sessions and an observer scored the responses while the teacher carried out his usual classroom activity.

Prior to the training sessions, E met alone with the individual teachers for an average of two forty-five minute periods for each procedure in order to acquaint the teachers with the group training methods and materials. Copies of the instructions were distributed to the teachers to acquaint them with the procedures. E answered any questions the teachers had and went over the procedures until they were comfortable with them.

In the group training sessions, the teacher, Ss, and E sat at a table in the back of the classroom while class was in session. The teacher read the instructions directly from a printed copy of the procedures while E scored Ss' responses. The remainder of the class, including the control group, was usually assisted by a teacher's aide or another E in classroom activity to divert their attention away from the group training. This classroom activity consisted of coloring, telling stories, reading, or watching educational television.

While each class had from two to five Ss in the experimental group, it was sometimes necessary to conduct the training sessions with less than the usual complement of Ss in order to obtain the data before the end of the school year. However, none of the Ss missed both training sessions on any training procedure.

Treatment

The experimental Ss received two training sessions on each of the four procedures--DQ, O, C, and ACC. Each training session took place within the classroom and was approximately forty-five minutes long. The control Ss remained in the classroom as did other children who were not participants of the study. Their attention was diverted by the use of activity which was generally of high interest to them.

Pretests

The same pretests previously used in Experiment IV were used. A short summary of each follows.

Vocabulary pretest. The vocabulary pretest (see Appendix B) was administered to ascertain that Ss understood key words on the six Piagetian pretests. Ss demonstrated their understanding of these words by pointing or putting out materials to illustrate their meaning. Children not demonstrating knowledge of the selected words were eliminated from further participation in the study.

Discontinuous quantity (DQ) conservation pretest. Two colors of wooden beads and different shaped glass beakers were used (see Appendix C). After establishing equivalence of beads between E's and S's beads in equal containers, a number of transformations were made by pouring S's beads into different beakers. After each transformation, S was questioned about whether he had the same number of beads as E and whether necklaces made from their beads would be the same length. Finally, as a check for response set, two beads were added to E's beaker and S was again asked if they had the same amount. S was asked to explain each answer given.

Correspondence (Corr) pretest. E used plastic chips to construct three different figures as models (see Appendix E). After E had constructed each model, S was instructed to copy the figure using the same number of chips. Then, E spread out his model and asked if they still had the same number of chips. After S had copied each model with chips, the above procedure was repeated except this time S used small sticks instead of chips. Finally, E added two chips to his model and spread the chips apart; S was again asked if they had the same amount of sticks and chips. An explanation was asked for each answer.

Continuous quantity (CQ) conservation pretest. After establishing quantity equivalence of two different colored balls of clay (see Appendix F), E successively transformed S's ball of clay into different shapes, then into two, three, and finally four smaller balls. The four smaller balls were next transformed into four different shapes. After each transformation, S was asked whether they had the same amount of clay. To check for response set, a portion of S's clay was then removed and he was again asked whether they had the same amount of clay. An explanation was asked for each answer.

Ordination (O) pretest. S was shown a picture of a stairway which was withdrawn and then was given eight sticks of varying heights to construct a stairway like the one in the picture (see Appendix G). After the stairway was constructed, seven more sticks of varying heights were presented, and S was instructed to place them between the other sticks to make a larger stairway. After correction and scoring, E made another stairway of smaller sticks above S's stairway; E then pointed to certain steps on his small stairway and asked S to point to the corresponding steps on his stairway. The same procedure was carried out with E's stairway reversed and with S's stairway in random order.

Cardination (C) pretest. S was presented with ten blocks from 1 x 1 x 1 to 1 x 1 x 10 inches and was asked to construct a stairway (see Appendix H). It was then shown that the second block could be cut into two blocks like the first and the third block could be cut into three blocks like the first, and so on. S was then asked how many blocks like the first one could be made if other blocks in the stairway were cut. After this, the order of the blocks was randomized, and the same question was asked for five different blocks.

Additive composition of classes (ACC) pretest. Two drawings of children were used (see Appendix J). First, a drawing showing two girls and five boys was presented and questions comparing the number of boys with the number of children were asked. Then, a second drawing showing ten girls was added to the first drawing, and questions comparing the number of girls with the number of children were asked. Finally, the second drawing was removed and more questions were asked about the first drawing only.

Group Training Procedures

Discontinuous quantity (DQ) group training. DQ training was administered in two parts, first using boxes and erasers and then sticks and cans (see Appendix S). One S and the teacher simultaneously put erasers into two small equal boxes until the bottoms of both boxes were full, and equivalence of the two quantities was established. The teacher's erasers remained in the original box but Ss' erasers were used for the transformations. Four larger boxes of different dimensions were successively presented, one at a time, each to a different S. Training cycle one (see Table 1.2) was carried out with Ss taking turns, first with their erasers in each individual box, then with their erasers divided between two of the boxes, and finally with their erasers divided among the four boxes. If any S failed to show a conserving response, training cycle two (see Table 1.2) was immediately carried out with him.

For the second part, two small decorated cans of equal size, which held exactly twelve rhythm sticks each, and four larger decorated cans were used. After equivalence of sticks in the two matched cans was established, Ss, in turn, made transformations of their sticks to each of the other four cans, then to two cans and finally to four cans. Training cycle two was carried out for Ss who gave nonconserving responses on cycle one (see Table 1.2).

One training session of approximately forty-five minutes duration was carried out for each of the two parts of the procedure.

Ordination (O) group training. The materials consisted of one-eyed wooden "people" of varied heights called Zerbils and their homes (wooden doors of corresponding heights). The task for the Ss was to first order the Zerbils from smallest to tallest, each S taking his turn with one Zerbil, and then to order the doors in the same manner (see Appendix T). After reversing the order of the doors as well as putting the

Zerbils in random order, Ss taking turns were asked to find the doors of the homes belonging to selected Zerbils. If any S failed he was immediately given extra training and allowed to correct his error.

Cardination (C) group training. In the first part of this two part procedure (see Appendix U), the Ss were given 15 blocks, each a one-inch cube, and were asked to take turns making the steps of a stairway, the first step one block high and the last step five blocks high. The teacher then asked, different Ss in turn, how many more blocks some steps had than others and how many blocks should be added or taken away to make two selected steps the same in height.

For the second part, the teacher presented six strips of felt from 1 x 1 to 1 x 6 inches and asked Ss to make a stairway, each S putting out one step at a time. The teacher then asked Ss in turn how many pieces like the first step in the stairway could be made from the other steps. Responses were checked by placing extra one-inch strips of a different color on the strip in question. Next, the teacher asked how many pieces like the third step could be made out of the sixth step and demonstrated that three steps like the first one made up the third step, and two steps like the third one made up the sixth step; therefore three units taken two times equals six. The extra felt pieces were then removed, and Ss were asked to take turns adding steps seven through ten (1 x 7 to 1 x 10 inches) to the stairway. Finally, the teacher asked Ss in turn how many steps like the first one could be made out of the various steps, both with the steps as a stairway and in random order.

If any S responded incorrectly, he was immediately given extra training on that step and allowed to correct his error.

Additive composition of classes (ACC) group training. For the first part, round yellow wooden beads, round green wooden beads, and blue square wooden beads were used (see Appendix V). Different proportions of the two colors of round beads were presented, and Ss, in turn, were asked questions such as, "Are there more green beads or more round beads?" or "Are there more yellow beads or more round beads?" Responses were checked by placing the beads in question in a notched wooden rectangle for comparison. Ss were then asked what colors a necklace made of round wooden beads would be and whether a necklace of round beads or one of green beads would be longer. Responses were checked by putting the beads on a wire for comparison. Ss were then asked to focus attention on round beads and wooden beads, and the same procedure was carried out comparing the number of beads having these dimensions.

For the second part, orange wooden rhythm sticks, blue wooden rhythm sticks, and blue wooden blocks were used. First, *S*s were given different proportions of the two colors of sticks and were asked questions comparing the number of a particular color of sticks with the number of wooden ones. Answers were checked by lining the sticks up, first those of the color in question and then all the wooden ones. The blocks were added later and *S*s were asked whether there were more blue things or more wooden things. *S*s in the groups took turns answering the above questions. Any *S* who responded incorrectly was immediately given additional training and allowed to correct his error.

Final posttests

The six final posttests, identical to the six pretests, were administered in two different sessions to the individual *S*s. One week after *S*s from a particular classroom had received DQ training, they received the DQ, Corr, and CQ final posttests. The control *S*s from the same classes also received these posttests at this time. Likewise, one week after O, C, and ACC training were completed, both experimental and control *S*s from each particular classroom received the O, C, and ACC final posttests. However, in some cases due to *S*s' absences and classroom priorities there was as much as a three-week delay between the last training session and final posttests.

Results

The *S*s' scores on the tests were computed as the percentage of the total possible correct. Figure 5.1 shows the pre- and posttest scores on the DQ, Corr, and CQ conservation tests. Figure 5.2 shows the pre- and posttest scores on the O, C, and ACC tests. Substantial increases are evident on the part of the experimental *S*s over the control *S*s on all posttests, except Corr and ACC.

Because the experimental *S*s had been trained in groups of approximately four *S*s, the analysis of covariance, with pretest scores as the covariate, was used to determine whether there were differences between performances of the experimental and control *S*s on the six posttests. Prior to the analysis, an arcsin transformation of the percentage scores was made. Moreover, since the *F* test is two-tailed and the direction of the difference between the means of the experimental and control conditions is specified in the present study, the .10, rather than the .05, level was used for rejection of the null hypothesis. The analysis of covariance showed significant differences between the two conditions on the DQ, O, and C posttests ($F = 6.27$, $df = 1/30$, $p < .05$; $F = 1.13$, $df = 1/30$, $p > .10$; $F = 2.81$, $df = 1/30$, $p > .10$; $F = 3.57$, $df = 1/35$, $p < .10$; $F = 3.20$, $df = 1/35$, $p < .10$; and $F = .67$, $df = 1/35$, $p > .10$ for the DQ, Corr, CQ, O, C, and ACC posttests respectively).

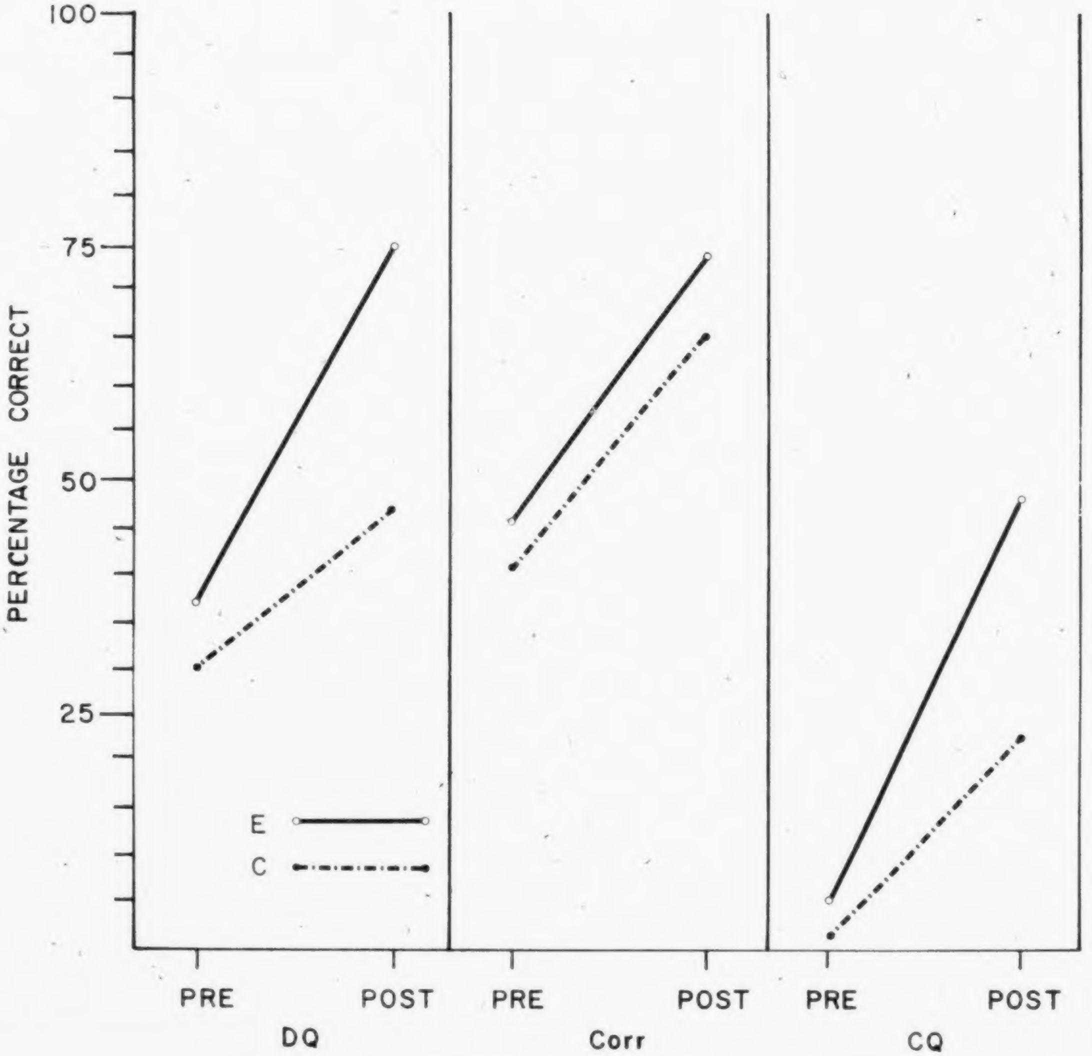

Figure 5.1 Performance of the two treatment groups on the DQ, Corr, and CQ pre- and posttests.

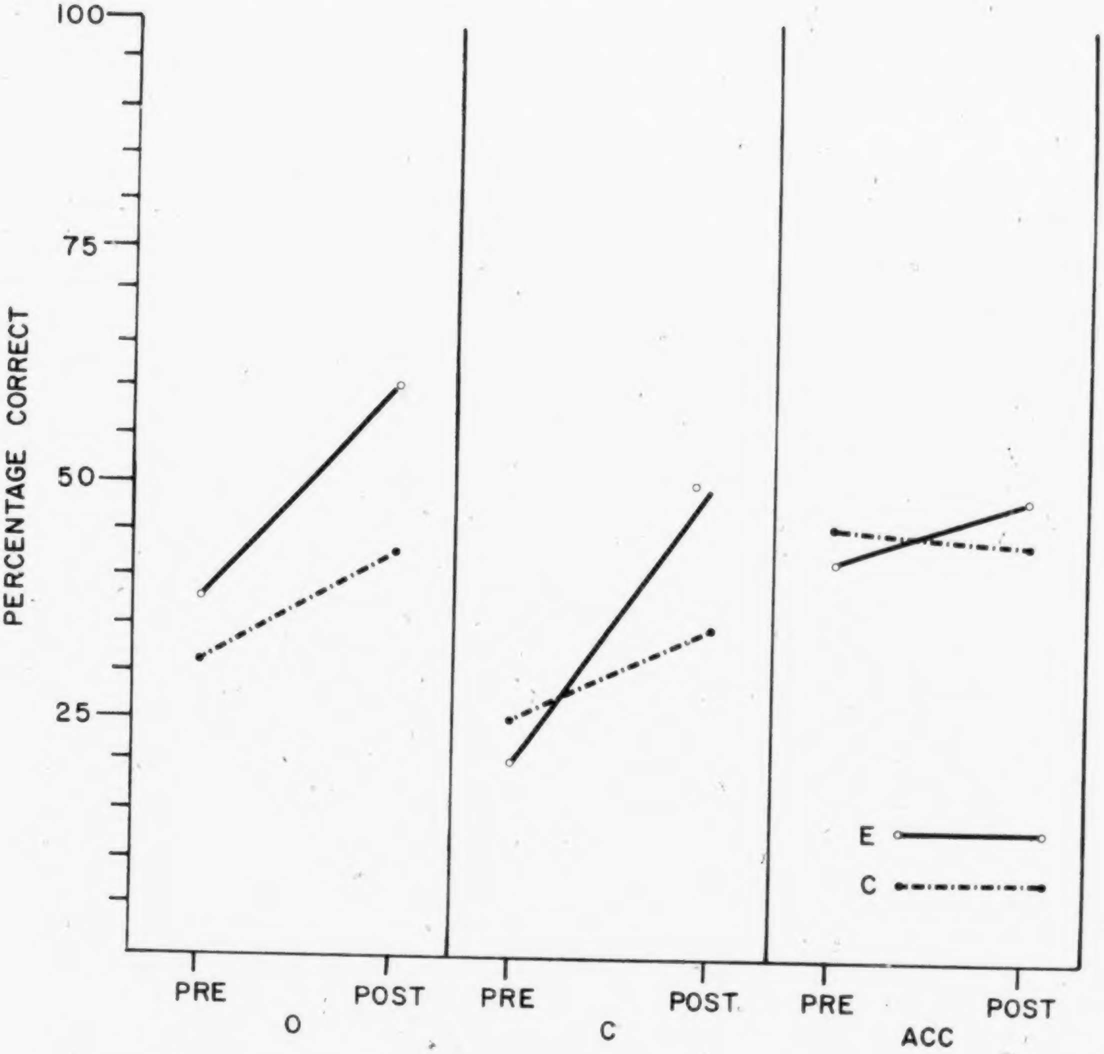

Figure 5.2 Performance of the two treatment groups on the O, C, and ACC pre- and posttests.

Furthermore, a repeated measure analysis of variance of the transformed pretest scores for all Ss was used to determine which of the six pretests were easier. The means of the six pretests were .42, .49, .16, .34, .22, and .44 for the DQ, Corr, CQ, O, C, and ACC respectively. The analysis showed the pretests differed significantly in difficulty ($F = 13.04$, $df = 5/185$, $p < .01$). Multiple comparisons were made by means of the Newman-Keuls method at the .05 level. Table 5.1 illustrates which tests differed significantly from the others. Ss' performance on the Corr, ACC, and DQ pretests was significantly higher than performance on the C and CQ posttests. Moreover, performance on the O pretest was significantly better than the CQ pretest. All other differences were nonsignificant.

Table 5.1

Significant differences
between performance on the six pretests.

Pretests		Corr	ACC	DQ	O	C	CQ
	Mean	.49	.44	.42	.34	.22	.16
Corr	.49					*	*
ACC	.44					*	*
DQ	.42					*	*
O	.34						*
C	.22						
CQ	.16						

*$p < .05$

The Pearson product-moment correlation coefficient was used to examine the relationships among the six pretests. Table 5.2 shows the correlation coefficients between tests. Only the three conservation pretests, DQ, Corr, and CQ were significantly related.

Moreover, the Pearson product-moment correlation coefficient was used to determine the relationship between pretest scores and individual difference, such as IQ, MA, and CQ. Table 5.3 shows the relationships among these variables. Performances on the Corr and O pretests were found to be related to MA. No other significant relationships were found.

Table 5.2

Relationships among the six Piagetian pretests.

Pretests	DQ	Corr	CQ	O	C	ACC
DQ		.70**	.65**	.22	.00	-.14
Corr			.52**	.25	.06	-.22
CQ				.13	.28	-.08
O					.02	-.04
C						.08
ACC						

** $p < .01$, $df = 36$

Table 5.3

Relationships between the
six Piagetian pretests and IQ, MA, and CA.

	Pretests					
	DQ	Corr	CQ	O	C	ACC
IQ	.06	.04	.11	-.09	.27	-.10
MA	.25	.33*	.22	.40*	.18	.12
CA	-.02	.14	.07	.22	-.02	-.04

* $p < .05$, $df = 34$

The Pearson product-moment correlation coefficient was also used to determine whether amount of improvement from pre- to posttest for the *S*s who received training was related to individual differences, such as IQ, MA, CA, or pretest score. Table 5.4 shows the correlation coefficients between these variables. Only amount of improvement on the DQ test and CA were positively related. On the other hand, improvement on all tests, except CQ, and pretest scores were negatively related. No other significant relationships were found.

Table 5.4

Relationships between test improvement from pre- to posttest and individual differences for Ss who received training.

Test Improvement	IQ	MA	CA	Pretest score
DQ	-.06	.37	.56*	-.63**
Corr	-.19	-.08	.28	-.52*
CQ	-.31	.33	.46	-.38
O	.26	-.17	-.20	-.58**
C	-.27	.03	.14	-.63**
ACC	.43	.29	.05	-.55*

* $p < .05$, df = 15, 17

** $p < .01$, df = 15, 17

The three conservation tests, DQ, Corr, and CQ, also included a confrontation question asked after some amount was added to one of the two quantities so they were no longer equivalent. Tables 5.5, 5.6, and 5.7 show the number of experimental and control Ss who passed this question, i.e., responded correctly that the quantities were no longer equal. The X^2 test was used to determine whether there was a difference in the proportion of experimental and control Ss who passed this question. No difference ($p > .05$) was found between the experimental and control Ss (X^2 = 2.00, .97, and 1.46 for the DQ, Corr, and CQ posttest respectively).

Table 5.5

Number of experimental and control Ss who passed the confrontation question on the DQ posttest.

	Experimental	Control	Total
Pass	15	16	31
Fail	2	0	2
Total	17	16	33

Table 5.6

Number of experimental and control Ss who passed the confrontation question on the Corr posttest.

	Experimental	Control	Total
Pass	16	16	32
Fail	1	0	1
Total	17	16	33

Table 5.7

Number of experimental and control Ss who passed the confrontation question on the CQ posttest.

	Experimental	Control	Total
Pass	11	7	18
Fail	6	9	15
Total	17	16	33

Discussion

Differences between performances by the experimental and control groups were found on the DQ, O, and C posttests, indicating that the DQ, O, and C group training procedures were effective. These experimental Ss, unlike those in the previous experiments, were not run to criterion and had to wait for their turn to participate; yet, these three group training procedures, particularly the DQ, were effective. On the other hand, although the ACC training procedure appeared to have been one of the most facilitating in Experiments II and IV, no significant difference was found between the experimental and control Ss on the ACC posttest.

It must be noted, however, that the circumstances under which training took place were rather unusual. There were several conditions in some groups which were detrimental to maximum training benefits. First, it was extremely difficult to keep the attention of all Ss in the experimental condition. Particularly when Ss consistently failed, the length of time between turns was rather long, and S's attention naturally wandered. Consequently, on these occasions, little learning took place through observation. Moreover, because training took place in classrooms with ongoing distractions, some Ss became interested in the activities of the control Ss, even to the point of wandering away from the experimental situation, especially on ACC training. In addition, two groups were disrupted by the behavior of children who deliberately refused to follow instructions or otherwise misbehaved. Consequently, in view of the above problems, it is surprising that any group procedures were effective.

In order to eliminate some of the above problems, it was suggested by some teachers that the number of Ss within a group be reduced to two. They felt this would serve to reduce the amount of time between turns and, consequently, maintain attention. Of course, this meant twice as many sessions would have been needed and, as it was, a few teachers were reluctant to participate because of the time commitment. Moreover, the teachers felt that if larger groups were desired, they would be more able to pick out groups of children who would work well together. Because of the experimental design of the present study, however, it was necessary that Ss be randomly assigned to groups, and, consequently, the constitution of all groups was not ideal. In addition, the teachers felt that it would be easier to work with children who were comparable in ability since much time was spent correcting the errors of slower children while the brighter children sat idly by. This problem, of course, never occurred in individualized training since the slower Ss would merely receive more training until criterion was reached.

The added confrontation question on the conservation tests did not allow distinction between the experimental and control Ss. The question appeared much too simple since inspection of the data showed that even Ss who were nonconservers answered the confrontation question correctly. Consequently, this question did not appear useful in distinguishing nonconservers from conservers.

The pretests in the present study, as in the previous ones, differed in difficulty. The order of difficulty of the pretests was Corr, ACC, DQ, O, C, and CQ in the present study. The order of these same pretests for educable Ss in Experiment IV was Corr, O, DQ, ACC, C, and CQ. It appears that the Corr pretest is the easiest whereas the C and CQ pretests are the most difficult for educable Ss who are low or intermediate in cognitive development. Again, however, it must be noted that the difficulty of the test may depend upon the type of materials used for testing. This view is supported by evidence in Experiment II that the ACC test using felt squares (see Appendix I) was extremely difficult. When this test was modified so that the only difference was the change in materials from felt squares to drawings of children (see Appendix J), the ACC test appeared to be quite easy as demonstrated by the results of Experiments IV and V.

Furthermore, the results of the present study, as those of the previous ones, also showed strong relationships among the three conservation tasks, DQ, Corr, and CQ. However, unlike Experiments II and IVa, no other relationships were found.

Performances on the Corr and O pretests only were found to be related to MA. Again, fewer relationships than expected, in accordance with previous results, were found between pretest scores and MA. On the other hand, as hypothesized, pretest scores were generally negatively related to amount of test improvement.

In summary, the DQ, O, and C group training procedures were effective, supporting hypotheses a, b, and c, whereas the ACC procedure was not. Considering the problems encountered, however, the above results are rather encouraging and indicate that, with minor changes, the group training procedures may be highly effective. Hypothesis e, performance on the pretests is related to MA, was only partially supported for the Corr and O pretests. Finally, hypothesis f, effectiveness of training is negatively related to pretest scores, was generally supported.

SUMMARY AND CONCLUSIONS

Objectives of the project

The primary objective of this project was to develop remedial procedures and materials for children with learning deficits in the area of arithmetic. Piaget's description of the stages in the development of conservation and various operations related to number understanding was used to assess the extent of retardates' cognitive functioning. That is, tests adapted from Piaget's clinical method were used as standardized procedures to assess retardates' functioning in areas such as conservation, ordination, cardination, and classification.

In addition, standardized training procedures were devised in order to facilitate development of the above operations related to number readiness. These procedures included features, such as manipulation of objects and introduction of conflict, which other investigators thought were instrumental to success. Moreover, additional features, such as individual programming, knowledge of results, and training to criterion were included. These training procedures were specifically developed to facilitate conservation, ordination, cardination, and classification. Experiments I-V were designed to examine the extent of facilitation of the above training procedures.

Summary of Experiments I-V

Experiment I. The Acquisition of Conservation of Quantity by Retarded Children. Experiment I was designed to determine whether educable retardates could be taught to conserve quantity. At the time this study was designed, no studies to this investigator's knowledge had attempted to facilitate conservation in retardates. Moreover, studies with normal children yielded mixed results, and investigators such as Kohlberg (1968) were quite pessimistic about the effects of training. Consequently, the first study was limited to conservation training. Ss' abilities on three types of conservation--discontinuous quantity (DQ), correspondence (Corr), and continuous quantity (CQ)--were tested. Ss who showed poor performance on two of the above three tests were randomly assigned to the DQ training, Corr training, CQ training, control, or control language group. After training, the same three tests were administered as posttests.

The results indicated that Ss who received training were generally superior to the control Ss on posttests of all three types of conservation. This meant that training on one type of conservation not only was successful in facilitating performance on the test directly related to it, but also showed transfer to performance on the other tests.

Other findings showed that performance on the pretests were related to MA, as well as CA. Moreover, the amount of improvement after training was negatively related to performance on the pretest and was unrelated to individual differences, such as IQ, MA, and CA. The results of Experiment I were very encouraging and led to a more ambitious undertaking, Experiment II.

Experiment II. The Acquisition of Conservation, Ordination, Cardination, and Classification by Educable Retardates. Experiment II was designed to determine whether it was possible to facilitate ordination, cardination, and classification, as well as conservation, in educable retardates. Educable retarded Ss were tested on discontinuous quantity (DQ) conservation, correspondence (Corr), continuous quantity (CQ) conservation, ordination (O), cardination (C), and additive composition of classes (ACC). The order of difficulty of the tests was DQ, Corr, CQ, C, O, and ACC. Ss who demonstrated poor performance on all pretests were assigned to level three. Ss who performed well on the conservation pretests, but failed either O or C, or both, and ACC were assigned to level two. Finally Ss who performed well on all tests except ACC were assigned to level one. Ss in each level were randomly assigned either to an experimental or control condition. The experimental Ss in level three were given DQ, Corr, O, C, and ACC training. The experimental Ss in level two were given O, C, and ACC training. The experimental Ss in level one were given ACC training only. The control Ss within each level received play sessions with clay equal to the average number of sessions the experimental Ss within that level spent in training.

The results of Experiment II indicated that the DQ, O, and ACC training procedures were highly effective at level three since the experimental group was significantly superior to the control group and performed as well as level one on these posttests. Corr and CQ effectiveness was questionable. At level two, the O and ACC training procedures were effective, whereas C was not. At level one, moreover, the ACC training procedure was effective. Of the five training procedures examined, DQ, O, and ACC appeared the most effective.

Further results in Experiment II indicated that performance on all pretests, except ACC, was related to both MA and CA. Moreover, the amount of improvement was negatively related to pretest scores, although unrelated to individual differences such as IQ, MA, and CA. It appears that training effectiveness was not selectively beneficial to certain Ss, depending upon their IQs or CAs. Rather, training was generally beneficial, and amount of improvement depended more on how much improvement was possible, i.e., S's performance on the pretests. Moreover, the ACC test appeared to be the most difficult of the six pretests. Finally, results of tests of arithmetic achievement were inconclusive.

Experiment III. The Acquisition of Quantity by Institutionalized Retardates. Experiment III was carried out in an attempt to determine whether the training procedures developed would be successful with populations other than educable retarded *S*s. Consequently, Experiment I with some modifications was replicated with a sample of institutionalized retardates. These *S*s consisted of both educable and trainable retardates who were given DQ, Corr, and CQ conservation pretests. All *S*s who failed at least two of the pretests were randomly assigned to the DQ training, Corr training, CQ training, or control group. The control group in Experiment III, unlike Experiment I, used the same materials and were asked the same types of questions as the DQ training group. The only difference between the groups was that reversals of the transformation to its original state were never carried out for the control group.

The results showed that on the DQ posttest there were no significant differences found among groups. It appeared that the control group showed an increase on the DQ posttest indicating that the control sessions using the DQ training materials without reversals was also of benefit. On the Corr and CQ tests, however, all three training groups were superior to the control group. The latter finding indicates that, although the control treatment facilitated the control group's performance on the DQ test, no transfer occurred to the other tests. On the other hand, the DQ, Corr, and CQ groups all showed transfer to tests not directly related to their training. The results of this study indicate that the effects of training are not limited to educable *S*s in special education classes. Institutionalized retardates, whose average IQs were lower and CAs were higher, also showed facilitation.

Experiment IV. The Effectiveness of Conservation, Ordination, Cardination, and Classification Training Procedures with Educable and Trainable Retardates. Experiment IV was designed to examine the effectiveness of the DQ, O, C, and ACC training procedures used in Experiment II with trainable, as well as educable, *S*s. Furthermore, this study was designed to determine whether these individualized training procedures were effective enough to be further developed as group training procedures. Educable and trainable *S*s were randomly assigned to four treatment groups--DQ training, O&C training, ACC training, and a control.

For the educable *S*s, all training groups were significantly superior to the control group on the tests directly related to their training. In addition, the DQ training group showed transfer to the CQ posttest, and both the DQ and ACC training groups showed transfer to the O posttest. Data from the educable Ss also showed positive relationships between pretest scores and MA and negative relationships between pretest scores and amount of improvement after training. Finally, delayed posttests, given approximately six months after the final posttests, showed a decrement only on the DQ posttest. No decrement was found on the O, C, and ACC delayed posttests.

For the trainable Ss, on the other hand, the results were somewhat disappointing. Only ACC training was effective since only the ACC training group was significantly superior to the control group, as well as the other training groups. Furthermore, no relationships were found between pretest performance and MA, although negative relationships were found between performance on four of the pretests and amount of improvement after training.

Experiment V. The Use of Group Procedures in Conservation, Ordination, Cardination, and Classification Training of Educable Retardates. For Experiment V, the DQ, O, C, and ACC individualized training procedures which were highly effective for educable Ss in Experiment IV were modified so that several Ss, instead of one, could be trained simultaneously. The group training procedures were developed in response to some teachers' comments that they seldom had time in the classroom to work with one child for the required length of time. Educable Ss were assigned to an experimental condition, which received training on DQ, O, C, and ACC, and to a control condition.

The results indicated that the DQ, O, and C group training procedures were successful. The use of group procedures, however, led to problems arising from bringing several children together to work on a task. For example, on occasions when one S was very slow at taking his turn, the other Ss were bored. In addition, since the experimental groups were run in the classrooms while the control Ss and other members of the class were engaged in telling stories, watching educational television, etc., some of the experimental Ss preferred the control activity. Consequently, it was surprising that the group training procedures were as successful as they were. Teachers' recommendations to remedy these problems were to decrease the number of children per group and to train children of similar ability within the same group.

Conclusions and Implications

The results of this research project have demonstrated that it is possible to accelerate cognitive development in retarded children by means of particular training procedures.

These training procedures, which focused upon operations related to number readiness, such as conservation, ordination, cardination, and classification, incorporated features which are believed instrumental to the success of training. These features for the individualized training sessions were individualized programming, knowledge of results, and training to criterion. The first two, individualized programming and knowledge of results, are closely related. In the designing of the training procedures in this series of studies, it was decided to take care of each error as it occurred. Immediately after S made an error, he was given extra training on the particular step which he had failed. The extra training both pointed out his error and allowed him to correct it. Furthermore, to insure the effectiveness of training, all Ss were run to criterion; that is, the training tasks were readministered until Ss responded correctly and no longer needed any extra training. The group training procedures, however, indicate that some success may also be achieved without training to criterion.

The results of this project generally showed positive relationships between pretest scores and MA. On the other hand, no relationships were found between amount of improvement after training and MA. Negative relationships, however, were consistently found between performance on the pretest and amount of improvement after training. The last results are in contrast to those obtained by Inhelder & Sinclair (1969) who found that training effects vary with Ss' initial developmental level. The general lack of relationships between improvement after training and individual differences such as IQ, MA, and CA, as well as the consistent negative relationship between improvement and pretest scores, indicate that the present training procedures were generally effective regardless of individual differences. It appears that the amount of improvement after training is limited primarily because of Ss' performance on the pretest; that is, the higher Ss' pretest score, the less improvement possible. The results of Experiment IVb with retardates, however, suggest that there may also be some limitation on training effectiveness for Ss with low IQs. More research is necessary before a more definite statement about training effects with trainable retardates can be made.

Inhelder & Sinclair (1969) also found that ACC training effects transfered to performance on conservation tasks. In Experiment IV which examined transfer effects, as well as facilitative effects of the DQ, O, C, and ACC training procedures, no transfer of ACC training to performance on the conservation posttests was found. Both the DQ and ACC training procedures, however, facilitated performance on the O pretest. Furthermore, training on one type of conservation generally showed transfer to the other types of conservation.

Examinations of the relationships between performance on the pretests showed strong correlations between the DQ, Corr, and CQ pretests. Experiment II which included the largest number of Ss, having a broader range of scores than Ss in the other studies, showed significant positive intercorrelations between all tests, except ACC. Performance on the ACC pretest appeared to be negatively related to performance on the conservation, as well as O, pretests.

Differences were also found in Ss' performance on the six pretests, DQ, Corr, CQ, O, C, and ACC. These differences, however, may result from the types of materials used. Evidence for this view comes from the apparent difference in difficulty with a change in materials for the ACC test. At first, the materials used were different colored felt squares which made up the class of cloth (see Appendix I). Because it was felt that the concept of cloth might not be familiar to trainable Ss, the materials were changed to drawings of boys and girls which made up the class of children (see Appendix J). On Experiment II, the extreme difficulty of the classification test with cloth was obvious; whereas on Experiment IV the classification test with children was one of the easiest of the six pretests. The only difference between the two tests was the materials; exactly the same questions were asked in the same order on both tests. Consequently, it appears that S's familiarity with the materials used on the test may be a large factor in determining the child's performance on it.

The pragmatic implications of this project for teachers naturally must be considered with some caution. First of all, this series of studies did not provide conclusive evidence that training facilitated ability in arithmetic. To obtain evidence of this nature, longitudinal studies with rather large numbers of children should be carried out. Large numbers would be necessary since, particularly in special education classes, the population of Ss is not stable and, over a period of time, there is a loss of Ss within a particular school. Furthermore, although the trained abilities, such as conservation, are considered necessary for number readiness, it is not yet known whether they are sufficient conditions for higher performance in arithmetic. It is the present investigator's view that, if the teacher first makes certain that the child does well on conservation, ordination, cardination, and perhaps classification, tasks, it will be much easier to teach him arithmetic. That is, a program including training in the above operations and then comprehensive training in mathematics would probably yield the best results.

REFERENCES

Achenbach, T. M. Conservation of illusion-distorted identity: Its relation to MA and CA in normals and retardates. Child Development, 1969, 40, 663-679.

Ahr, P. R., & Youniss, J. Reasons for failure on the class inclusion problem. Child Development, 1970, 41, 131-143.

Beilin, H. Learning and operational convergence in logical thought development. Journal of Experimental Child Psychology, 1965, 2, 317-339.

Berlyne, D. Les équivalences psychologiques et les notions quantitatives. In J. Piaget (Ed.), Etudes d'épistémologie génétique, 1960, 12, 1-76.

Bittner, A. C., & Shinedling, M. M. A methodological investigation of Piaget's concept of conservation of substance. Genetic Psychology Monographs, 1968, 77, 136-165.

Brison, D. W., & Bereiter, C. Acquisition of conservation of substance in normal, retarded, and gifted children. Ontario Institute for Studies in Education, Educational Research Series, 1967, No. 2, 53-72.

Dodwell, P. C. Children's understanding of number concepts: Characteristics of an individual and of a group test. Canadian Journal of Psychology, 1961, 15, 29-36.

Elkind, D. The development of qualitative thinking: A systematic replication of Piaget's studies. Journal of Genetic Psychology, 1961, 98, 37-46.

Engelman, S. Cognitive structures related to the principle of conservation. Ontario Institute for Studies in Education, Educational Research Series, 1967, No. 2, 25-51.

Flavell, J. H. Developmental psychology of Jean Piaget. Princeton, N.J.: Van Nostrand, 1963.

Ford, Leroy H., Jr. (State U. New York, Buffalo) Predictive versus perceptual responses of Piaget's water-line task and their relation to distance conservation. Child Development, 1970, 41 (1), 193-204.

Furth, Hans G. (Catholic U.) Piaget on uses and abuses of philosophy. Acta Psychologica, Amsterdam, 1969, 29 (2), 195-204.

Gelman, R. Conservation acquisition: A problem of learning to attend to relevant attributes. Journal of Experimental Child Psychology, 1969, 7, 167-187.

Goldschmid, M. Different types of conservation and nonconservation and their relation to age, sex, IQ, MA, and vocabulary. Child Development, 1967, 38, 1230-1246.

Goldschmid, M. Role of experience in the acquisition of conservation. Paper presented at the meeting of the American Psychological Association, San Francisco, September, 1968.

Gottfried, Nathan W. (U. Minnesota) The relationship between concepts of conservation of length and number. Journal of Genetic Psychology, 1969, 114 (1), 85-91.

Gruen, G. E. Experiences affecting the development of number conservation in children. Child Development, 1965, 36, 963-979.

Halford, G. S., & Fullerton, T. J. A discrimination task which induces number conservation. Child Development, 1970, 41, 205-213.

Halford, Graeme S. (U. Newcastle upon Tyne, England) An experimental analysis of the criteria used by children to judge quantities. Journal of Experimental Child Psychology, 1969, 8 (2), 314-327.

Halford, Graeme S. (U. Newcastle, Australia) An experimental test of Piaget's notions concerning the conservation of quantity in children. Journal of Experimental Child Psychology, 1968, 6 (1), 33-43.

Hall, E. A conversation with Jean Piaget and Barbell Inhelder. Psychology Today, 1970, 3 (12), 25-32.

Hall, V. C., & Kingsley, R. Conservation and equilibrium theory. Journal of Genetic Psychology, 1968, 113, 195-213.

Hood, H. B. An experimental study of Piaget's theory of the development of number in children. British Journal of Psychology, 1962, 53, 273-286.

Hooper, Frank H. (West Virginia U.) Piaget's conservation tasks: The logical developmental priority of identity conservation. Journal of Experimental Child Psychology, 1969, 8 (2), 234-249.

Inhelder, B. The diagnosis of reasoning in the mentally retarded. New York: John Day, 1968.

Inhelder, B., & Sinclair, H. Learning cognitive structures. In Mussen, P.H., Langer, J., & Covington, M. (Eds.), Trends and Issues in Developmental Psychology. New York: Holt, Rinehart, & Winston, 1969.

Keasey, Carol T., & Charles, Don C. Conservation of substance in normal and mentally retarded children. Journal of Genetic Psychology, 1967, 111, 271-279.

Kingsley, Richard, & Hall, Vernon C. Training conservation through the use of learning sets. Child Development, 1967, 38, 1111-1126.

Kohlberg, L. Early education: A cognitive-developmental view. Child Development, 1968, 39, 1013-1062.

Kohnstamm, G. A. An evaluation of part of Piaget's theory. Acta Psychologica, 1963, 21, 313-356.

Kohnstamm, G. A. Teaching children to solve a Piagetian problem of class inclusion. Amsterdam: North Holland Publishing Co., 1967.

Kooistra, W. H. Developmental trends in the attainment of conservation, transitivity, and relativism in the thinking of children: A replication and extension of Piaget's ontogenetic formulations. Unpublished doctoral dissertation. Wayne State University, 1963.

Lister, C. M. The development of a concept of weight conservation in E.S.N. children. British Journal of Educational Psychology, 1969, 39, 245-252.

Lister, C. M. The development of a concept of volume conservation in E.S.N. children. British Journal of Educational Psychology, 1970, 40, 55-64.

Lovell, K., & Slater, A. The growth of the concept of time: A comparative study. Journal of Child Psychology and Psychiatry, 1960, 1, 179-190.

Lumsden, E. A., & Kling, J. K. The relevance of an adequate concept of "bigger" for investigations of size conservation: A methodological critique. Journal of Experimental Child Psychology, 1969, 8, 82-91

McManis, Donald L. (U. Kansas, Bureau of Child Research) Comparisons of gross, intensive, and extensive quantities by normals and retardates. Child Development, 1969, 40 (1), 237-244.

Mermelstein, E., & Meyer, E. Conservation training techniques and their effects on different populations. Child Development, 1969, 40, 471-490.

Mermelstein, E., & Schulman, L. Lack of formal schooling and the acquisition of conservation. *Child Development*, 1967, *38*, 39-52.

Morf, A. Apprentissage d'une structure logique concrète (inclusion): effets et limites. In A. Morf, J. Smedslund, Vinh-Bang, & J. F. Wholwill L'apprentissage des structures logiques. *Etudes* d'épistémologie génétique, Vol. 9. Paris: Presses Universitaires France, 1959.

Murray, Frank B. Cognitive conflict and reversibility training in the acquisition of length conservation. *Journal of Educational Psychology*, 1968, *59*, 82-87.

Murray, Frank B., & Johnson, Paul E. (U. Minnesota) Reversibility in nonconservation of weight. *Psychonomic Science*, 1969, *16* (6), 285-287.

Nummedal, Susan G., & Murray, Frank B. (U. Minnesota) Semantic factors in conservation of weight. *Psychonomic Science*, 1969, *16* (6), 323-324.

Overbeck, C., & Schwartz, M. Training in conservation of weight. *Journal of Experimental Child Psychology*, 1970, *9*, 253-264.

Piaget, J. *The child's conception of number*. London: Routledge, 1952.

Piaget, J. Development and learning. In R. Ripple, & V. Rockcastle (Eds.), *Piaget rediscovered, a report on cognitive studies and curriculum development*. Ithaca, N.Y.: Cornell University, School of Education, 1964, 7-20.

Peters, D. L. Verbal mediators and cue discrimination in the transition from nonconservation to conservation of number. *Child Development*, 1970, *41*, 707-721.

Rothenberg, B., & Orost, J. H. The training of conservation of number in young children. *Child Development*, 1969, *40*, 707-726.

Saltz, E., & Hamilton, H. (Wayne State University Center for the Study of Cognitive Processes) Concept conservation under positively and negatively evaluated transformations. *Journal of Experimental Child Psychology*, 1968, *6* (1), 44-51.

Sawada, Daiyo, & Nelson, L. Doyal (U. Alberta, Edmonton, Canada) Conservation of length: Methodological Considerations. *Alberta Journal of Educational Research*, 1968, *14* (1), 23-35.

Sigel, Irving E., & Hooper, Frank H. *Logical thinking in children*. New York: Holt, Rinehart, & Winston, Inc., 1968.

Sigel, I. E., Roeper, A., & Hooper, F. H. A training procedure for acquisition of Piaget's conservation of quantity: A pilot study and its replication. *British Journal of Educational Psychology*, 1966, *36*, 301-311.

Smedslund, J. The acquisition of conservation of substance and weight in children. II. External reinforcement of conservation of weight and the operations of addition and subtraction. *Scandinavian Journal of Psychology*, 1961, *2*, 71-84. (a)

Smedslund, J. The acquisition of conservation of substance and weight in children. III. Extinction of conservation of weight acquired "normally" and by means of empirical controls on a balance scale. *Scandinavian Journal of Psychology*, 1961, *2*, 85-87. (b)

Smedslund, J. The acquisition of conservation of substance and weight in children. IV. An attempt at extinction of the visual components of the weight concept. *Scandinavian Journal of Psychology*, 1961, *2*, 153-155. (c)

Stearns, Kathryn, & Borkowski, John G. (Oberlin Coll.) The development of conservation and horizontal-vertical space perception in mental retardates. *American Journal of Mental Deficiency*, 1969, *73* (5), 785-790.

Strauss, S., & Langer, J. Operational thought inducement. *Child Development*, 1970, *41*, 163-175.

Sullivan, E. V. Acquisition of conservation of substance through film modeling techniques. *Ontario Institute for Studies in Education, Educational Research Series*, 1967, No. 2, 11-23.

Wallach, L., & Sprott, R. Inducing number conservation in children. *Child Development*, 1964, 35, 1057-1071.

Wallach, L., Wall, J., & Anderson, L. Number conservation: The roles of reversibility, addition-subtraction, and misleading perceptual cues. *Child Development*, 1967, *38*, 425-442.

Winer, B. J. *Statistical Principles in Experimental Design*. New York: McGraw-Hill, 1962.

Wohlwill, J. F., & Lowe, R. C. An experimental analysis of the development of the conservation of number. Child Development, 1962, 33, 153-167.

Woodward, M. The behavior of idiots interpreted by Piaget's theory of sensorimotor development. British Journal of Educational Psychology, 1959, 29, 60-71.

Appendix A

Test: Vocabulary I

Materials needed: Some chips
Some colored water for "pop"
Two 150 ml. glasses

Procedures:	Instructions and Questions
POUR SOME AMOUNT OF "POP" INTO ONE GLASS. POINT TO OTHER GLASS.	1. Pour some pop into this glass so that there is *more* in my glass.
	2. Now make it so that we both have the *same* amount... Do we have the same amount now?
	3. Now make it so that you have *as much* pop *as* I have...
	4. Now make it so that there is *less* in my glass...
REMOVE GLASSES, ETC. PRESENT CHIPS. PUT OUT FOUR CHIPS IN A ROW. SHOW CHILD HIS CHIPS.	5. Here are some chips for you. Put some chips out here so that you have *more* chips than I do...
	6. Now make it so that we both have the *same* number of chips... Do we have the same number now?
	7. Now fix it so that you have *as many* chips *as* I have...
	8. Now make it so that you have *less* chips than I have...

Test Log: Vocabulary I

Tape: Number______ Side______ Meter Number______ Date:____________________

Subject No.______ Group______ School________________ E__________ O__________

Starting Time______________ Finishing Time______________ Total Time______________

1.	More	P	F	5.	More	P	F
2.	Same	P	F	6.	Same	P	F
3.	As much as	P	F	7.	As many as	P	F
4.	Less	P	F	8.	Less	P	F

Appendix B

Test: Vocabulary II

Materials needed: 7 sticks of varying heights and two different colors of chips

Procedures:		Instructions and Questions
PRESENT 7 STICKS IN RANDOM ORDER.		Here are some sticks.
	1.	Pick out the smallest stick... Which is the next smallest stick?...
	2.	Pick out the biggest stick... Which is the next biggest stick?...
	3.	Pick out the shortest stick... Which is the next shortest stick?...
	4.	Pick out the tallest stick... Which is the next tallest stick?...
PUT THE STICKS IN CORRECT ORDER. POINT TO THIRD STICK.	5.	Here is a line of sticks with the tallest stick in back and the shortest stick in front. Point to the stick in front of this one... Point to the stick in back of this one...
PICK UP ONE STICK.	6.	Put this stick in between the others...

PRESENT CHIPS. GIVE CHILD HIS CHOICE OF COLOR.	1.	Put out ten chips in a row... Count them...
	2.	Which is first in the row?... Which is last?... Second?... Third?... Seventh?... Ninth?... Tenth?...

MOVE CHILD'S ROW OF CHIPS
ASIDE IN A PILE. THEN PUT
4 CHIPS OF ANOTHER COLOR
IN A ROW.

3. Put some chips out here so that you have more chips that I do...

4. Now make it so that we both have the same number of chips...

Test Log: Vocabulary II

Tape: Number_______ Side_______ Meter Number_______ Date:_____________________

Subject No.______ Group______ School___________________ E__________ O____________

Starting Time_________________ Finishing Time________________ Total Time______________

1.	Smallest	P	F	Next smallest	P	F
2.	Biggest	P	F	Next biggest	P	F
3.	Shortest	P	F	Next shortest	P	F
4.	Tallest	P	F	Next tallest	P	F
5.	In front of	P	F	In back of	P	F
6.	In between	P	F			

- -

1. Ten chips in row P F Miscount__________

2.	First?	P	F
	Last?	P	F
	Second?	P	F
	Third?	P	F
	Seventh?	P	F
	Ninth?	P	F
	Tenth?	P	F
3.	More?	P	F
4.	Same?	P	F

Appendix C

Test: Conservation of Discontinuous Quantity

Materials needed: 2 sets of large wooden beads, identical except for color; glass containers of varying sizes and shapes:

Two 600 ml. beakers ("A")
One 150 x 75 mm. dish ("M")
Two 250 ml. beakers ("B")
Four 150 ml. beakers ("C")

Procedures:		Instructions and Questions
PRESENT TWO "A" BEAKERS (600 ml.)		Here are two jars. One for you, and one for me.
PRESENT TWO SETS OF 16 BEADS, EACH SET A DIFFERENT COLOR. GIVE CHILD THE BEADS HE CHOOSES.		And here are some beads for both of us. Which color do you like? Now every time I put a bead in my jar, you put a bead in yours, OK?...
ESTABLISH EQUIVALENCE: PUT BEADS INTO BEAKER ONE AT A TIME, UNTIL 14 ARE IN THE BEAKER. SEE THAT THE CHILD HAS 14 ALSO AND BELIEVES THAT THE QUANTITIES ARE EQUAL.	1.	Do you have the same number of beads in your jar as I have in mine, or does one of us have more?... How can you tell?
	2.	If we made a necklace for me with my beads and one for you with your beads, would they be the same or would one of them be longer?... How can you tell?
		Now watch what I do.
PRESENT ONE "C" BEAKER (150 ml.). POUR BEADS FROM CHILD'S "A" BEAKER INTO THE "C" BEAKER.	3.	Now do you have the same number of beads there (POINT TO "C" BEAKER) as I have here, or does one of us have more?... How can you tell?

	4.	If we made a necklace for me with my beads and one for you with your beads, would they be the same, or would one of them be longer?... How can you tell?
PRESENT "M" DISH (150 x 75 mm.) AND POUR CHILD'S BEADS FROM "C" BEAKER.		Let's pour your beads into this dish.
	5.	Do you have the same number of beads as I have, or does one of us have more?... How can you tell?
	6.	If we made a necklace for me with my beads and one for you with your beads, would they be the same, or would one of them be longer?... How can you tell?
		Let's see what happens now.
PRESENT TWO "B" BEAKERS (250 ml.) AND POUR CHILD'S BEADS INTO THESE TWO BEAKERS.	7.	Do you have the same number of beads as I have, or does one of us have more? ... How can you tell?
	8.	If we made a necklace for you with your beads, and a necklace for me with my beads, will they be the same, or will one of them be longer?... How can you tell?
PRESENT FOUR "C" BEAKERS, AND POUR CHILD'S BEADS THROUGHOUT THE FOUR BEAKERS.	9.	Now do you have the same number of beads as I do, or does one of us have more?... How can you tell?
	10.	If we made a necklace for you with your beads, and a necklace for me with my beads, will they be the same, or will one of them be longer?... How can you tell?
*ADD 2 BEADS TO ONE OF CHILD'S BEAKERS.	*11.	Now do you have the same number of beads as I do, or does one of us have more?... How can you tell?

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*Used only in Studies IV and V.

Test Log: Conservation of Discontinuous Quantity

Tape: Number_______ Side_______ Meter Number_______ Date:__________________________

Subject No.______ Group_______ School_______________ E__________ O_______________

Starting Time________________ Finishing Time_______________ Total Time_____________

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1. Two "A" beakers. Equal? P F
Reason:

2. Necklace length? P F
Reason:

3. "C" beaker. Equal? P F
Reason:

4. Necklace length? P F
Reason:

5. "M" beaker. Equal? P F
Reason:

6. Necklace length? P F
Reason:

7. Two "B" beakers. Equal? P F
Reason:

8. Necklace length? P F
Reason:

9. Four "C" beakers. P F
Reason:

10. Necklace length? P F
Reason:

*11. Equal? P F
Reason:

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*Used only in Studies IV and V.

Appendix D

Test: Correspondence I

Materials needed: Two piles of different colored chips
Twenty matchsticks

Procedures:	Instructions and Questions
GIVE CHILD THE COLOR OF CHIPS HE PREFERS.	Here are some colored chips. Which color do you like?
TAKE 11 CHIPS FROM THE PILE AND DISTRIBUTE THEM RANDOMLY IN THE FORM OF AN UNSTRUCTURED NONOVERLAPPING FIGURE.	Take the same number of chips as I have down here, and make the same thing I just did...
ALLOW CHILD TO WORK WITH HIS CHIPS UNTIL HE BELIEVES THE FIGURES EQUAL.	1. Do you have the same number of chips there as I have here, or does one of us have more?... How can you tell?
SPREAD E'S CHIPS OUT.	Watch what I do.
	2. Do you now have the same number of chips there as I have here?... How can you tell?
REMOVE THE CHILD'S CHIPS AND PRESENT HIM WITH STICKS. PUT E'S CHIPS BACK INTO A SMALLER FIGURE.	Now do the same things with these sticks that you did with the chips. Take the same number of sticks as I have chips, and put them down here the same way...
ALLOW CHILD TO WORK WITH HIS STICKS UNTIL HE BELIEVES THE FIGURES EQUAL.	3. Do you have the same number of sticks as I have chips, or does one of us have more?... How can you tell?

SPREAD E'S CHIPS AGAIN.	Watch what I do.
	4. Now do you have the same number of sticks as I have chips, or does one of us have more?... How can you tell?
REMOVE STICKS. USE 12 OF THE CHIPS TO FORM TWO PARALLEL ROWS OF 6 CHIPS. REPEAT ABOVE PROCEDURE AND QUESTIONS FOR THIS FIGURE.	
REPEAT SAME PROCEDURES AGAIN FOR A RHOMBUS FIGURE. (12 CHIPS)	

Test Log: Correspondence I

Tape: Number_______ Side_______ Meter Number_______ Date:____________________

Subject No.______ Group_______ School__________________ E__________ O__________

Starting Time_______________ Finishing Time_____________ Total Time________________

Random figure Same

1. Chips #______ P F Miscount__________
   Comment:

2. Spread. Equal? P F
   Reason:

3. Sticks: #______ P F
   Reason:

4. Spread. Equal? P F
Reason:

Parallel rows 12

1. Chips #______ P F Miscount__________
Comment:

2. Spread. Equal? P F
Reason:

3. Sticks: #______ P F
Reason:

4. Spread. Equal? P F
Reason:

Rhombus 12

1. Chips #______ P F Miscount__________
Comment:

2. Spread. Equal? P F
Reason:

3. Sticks: #______ P F
Reason:

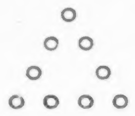
4. Spread. Equal? P F
Reason:

Appendix E

Test: Correspondence II

Materials needed: Two piles of different colored chips
Twenty matchsticks

Procedures:		Instructions and Questions
GIVE CHILD THE COLOR OF CHIPS HE PREFERS.		Here are some colored chips. Which color do you like?
TAKE 9 CHIPS FROM YOUR PILE, AND DISTRIBUTE THEM TO FORM A CROSS.		Take the same number of chips as I have done here, and make the same thing I just did...
o o o o o o o o o		
ALLOW CHILD TO WORK WITH HIS CHIPS UNTIL HE BELIEVES THE FIGURES EQUAL.	1.	Do you have the same number of chips there as I have here, or does one of us have more?... (Who?) How can you tell?
SPREAD E'S CHIPS OUT.		Watch what I do.
	2.	Do you now have the same number of chips there as I have here, or does one of us have more? ... (Who?) How can you tell?
REMOVE THE CHILD'S CHIPS AND PRESENT HIM WITH STICKS. PUT E'S CHIPS BACK INTO A SMALLER FIGURE.		Now do the same things with these sticks that you did with the chips. Take the same number of sticks as I have chips, and put them down here the same way.

ALLOW CHILD TO WORK WITH HIS STICKS UNTIL HE BELIEVES THE FIGURES EQUAL.	3. Do you have the same number of sticks as I have chips, or does one of us have more?... (Who?) How can you tell?
SPREAD E'S CHIPS AGAIN.	4. Now do you have the same number of sticks as I have chips, or does one of us have more?... (Who?) How can you tell?
REMOVE STICKS. USE 12 OF THE CHIPS TO FORM TWO PARALLEL ROWS OF 6 CHIPS. REPEAT ABOVE PROCEDURE AND QUESTIONS FOR THIS FIGURE.	
USE 9 CHIPS. REPEAT SAME PROCEDURES AGAIN FOR A TRIANGLE FIGURE. 	
*ADD TWO CHIPS TO E'S TRIANGLE.	*5. Now do you have the same number of sticks as I have chips, or does one of us have more?... How can you tell?

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*Used only in Studies IV and V.

Test Log: Correspondence II

Tape: Number_______ Side_______ Meter Number_______ Date:______________________

Subject No.______ Group________ School_______________ E__________ O__________

Starting Time________________ Finishing Time______________ Total Time_____________

Cross of (9)			Same	Who Has More?
1. Chips #_______ Comment:	P	F	Miscount_______	E S
2. Spread. Equal? Reason:	P	F		E S
3. Sticks: #_______ Reason:	P	F	Miscount_______	E S
4. Spread. Equal? Reason:	P	F		E S
Parallel rows 12				
1. Chips #_______ Comment:	P	F	Miscount_______	E S

2. Spread. Equal? P F E S
Reason:

3. Sticks: #_______ P F Miscount_______ E S
Reason:

4. Spread. Equal? P F E S
Reason:

Triangle 9

1. Chips #_______ P F Miscount_______ E S
Comment:

2. Spread. Equal? P F E S
Reason:

3. Sticks: #_______ P F Miscount_______ E S
Reason:

4. Spread. Equal? P F E S
Reason:

*5. Add 2 to E. P F E S

---

*Used only in Studies IV and V.

Appendix F

Test: Conservation of Continuous Quantity

Materials needed: 2 balls of clay identical except for color

Procedures:		Instructions and Questions
PRESENT THE TWO EQUAL BALLS OF CLAY.		Here is some clay for you, and some for me.
	1.	Do you have the same amount of clay as I have, or does one of us have more?
IF CHILD CLAIMS THEY ARE UNEQUAL:		Make them the same... Now are they the same?
		How can you tell?
STRETCH "YOUR" BALL INTO A LONG SAUSAGE-LIKE SHAPE.		All right, now watch what I do.
	2.	Now do you have the same amount of clay as I have, or does one of us have more?... How can you tell?
ROLL YOUR CLAY UP AND FLATTEN INTO A PANCAKE SHAPE.	3.	Do you have the same amount of clay as I have, or does one of us have more?... How can you tell?
BREAK YOUR CLAY IN HALF, AND FORM TWO SMALL BALLS.	4.	Do you have the same amount of clay as I have, or does one of us have more?... How can you tell?
BREAK ONE OF THE SMALLER BALLS IN HALF AGAIN, AND ROLL INTO TWO SMALLER BALLS.	5.	Do we now have the same amount of clay, or does one of us have more?... How can you tell?

BREAK SECOND SMALLER BALL IN HALF ALSO, TO MAKE 4 SMALL BALLS. (CHILD MAY HELP)	6.	Do we now have the same amount of clay, or does one of us have more?... How can you tell?
MAKE THE 4 SMALL BALLS INTO A CUP, A SAUSAGE, A PANCAKE, AND A CUBE. (CHILD MAY HELP)	7.	Do you have the same amount of clay there (INDICATING HIS UNTOUCHED BALL OF CLAY) as I have here, (INDICATING THE FOUR SHAPES) or does one of us have more?... How can you tell?
*TAKE 1 OF THE 4 PIECES AWAY.	*8.	Do you have the same amount of clay there as I have here, or does one of us have more?... How can you tell?

Test Log: Conservation of Continuous Quantity

Tape: Number______ Side_______ Meter Number_______ Date:____________________

Subject No.______ Group________ School________________ E__________ O__________

Starting Time______________ Finishing Time_____________ Total Time____________

---

1. Equivalence P F
   Reason:

2. Sausage. Equal? P F
   Reason:

---

*Used only in Studies IV and V.

3. Pancakes. Equal? P F
Reason:

4. Two balls (halves). Equal? P F
Reason:

5. Three balls. Equal? P F
Reason:

6. Four balls. Equal? P F
Reason:

7. Four shapes. Equal? P F
Reason:

*8. Take 1 piece away from S. Equal? P F
Reason:

---

*Used only in Studies IV and V.

Appendix G

Test: Ordination

Materials needed: 15 sticks from 4 inches to 10 inches long,
each differing 3/8 inch in height;
a long stick used as guide;
picture of stairway

Procedures:		Instructions and Questions
PRESENT 8 STICKS (#1, 3, 5, 7, 9, 11, 13, 15) IN RANDOM ORDER BUT IN A ROW.	1.	Here are some wooden sticks. Which one is the shortest?... Let's put it at one end (TO CHILD'S LEFT).
LEVEL OUT BOTTOM ENDS AGAINST GUIDE STICK.	2.	Find the next shortest stick and put it next to the shortest one. (CORRECT IF WRONG.)
AFTER MARKING CHILD'S RESPONSE ON LOG, CORRECT ANY ERRORS.		
PRESENT PICTURE OF STAIRWAY.		Do you know what a stairway is?... (SHOW CARDBOARD PICTURE.) Here is a picture of a stairway. Do you know what steps are?... Here are the steps in the picture. (POINT.) All the steps together make up a stairway.
REMOVE PICTURE OF STAIRWAY FROM CHILD'S VIEW.		Let's pretend these sticks are steps. Use this stick for the ground (POINT TO GUIDE STICK) and make sure that each step touches it.
E SHOULD PUT THE FIRST TWO STICKS AGAINST THE GUIDE STICK FOR CHILD.		See, like this...

3. Now put the other sticks next to these two and make a stairway so that it will go from the shortest step to the tallest step. (IF NEEDED: "Remember each step must touch the ground.")

AFTER CHILD FINISHES, SCORE NUMBER OF ERRORS. CORRECT THE ORDER OF THE STAIRWAY VERY QUICKLY. (NO TEACHING.)

PRESENT 7 STICKS (#2, 4, 6, 8, 10, 12, 14).

4. Here are some steps that were left out before. Can you put these steps in between the others where they belong to make a bigger stairway?...

CHILD IS NOT ALLOWED TO BREAK HIS ORIGINAL STAIRWAY.

(You can move them apart if you want to.)

CORRECT ORDER AFTER SCORING. (NO TEACHING.)

NOTE HOW HIGH THE CHILD CAN COUNT WITHOUT DIFFICULTY. REMOVE THOSE STICKS HE CAN'T COUNT.

5. Count the sticks...

CONSTRUCT A STAIRCASE WITH THIN STICKS IN CORRESPONDENCE WITH AND DIRECTLY ABOVE CHILD'S STAIRWAY.

Now I'm going to make a stairway like yours...

(#3, 5, 8)

6. If I climbed up so many steps on my stairway and reached this step (POINT TO #3) and you climbed the same number of steps on your stairway, point to the step that you would be on...

REPEAT QUESTION ON #5, 8.

REVERSE THE ORDER OF E'S STAIRWAY. (#4, 7, 9)	7. If I climbed up so many steps on my stairway and reached this step (POINT TO #4 ON E'S STAIRWAY), which step would you be on if you climbed the same number of steps?... Point to it... REPEAT QUESTION ON #7, 9.
REMOVE ALL STEPS HIGHER THAN #7 IN BOTH STAIRWAYS (LEAVE #7 IN). THEN DISARRANGE CHILD'S STAIRWAY. KEEP BOTTOM EDGE EVEN AND SPREAD STICKS SLIGHTLY. PUT GUIDE STICK UNDER CHILD'S STICK AFTER DISARRANGEMENT.	8. Remember the way the stairway was before?... You can move the steps if you want to. If I climbed up so many steps on my stairway and reached this step (POINT TO #2 ON E'S STAIRWAY), which step would you be on if you climbed up the same number of steps?... Point to it...
IF NEEDED, TELL CHILD HE CAN MOVE THE STICKS AROUND IF HE WANTS TO.	REPEAT QUESTION WITH #4, 6.

Test Log: Ordination

Tape: Number_______ Side_______ Meter Number_______ Date:____________________

Subject No.______ Group________ School______________ E__________ O__________

Starting Time______________ Finishing Time_____________ Total Time______________

---

1. Q. Shortest P F

2. Q. Next shortest P F

3. Make stairway P F # errors______

4.	Forgotten sticks	P	F	# errors______
5.	Count	Note #______		
6.	Match #3	P	F	
	Match #5	P	F	
	Match #8	P	F	
7.	Reverse-Match #4	P	F	
	" " #7	P	F	
	" " #9	P	F	
8.	Disarrange-Match #2	P	F	
	" " #4	P	F	
	" " #6	P	F	

Appendix H

Test: Cardination

Materials needed: Ten one-inch wooden blocks, 1 to 10 inches in length; guide stick

Procedures:		Instructions and Questions
PRESENT SERIES OF WOODEN BLOCKS.	1.	Make a stairway with these blocks. Start with the shortest one. Then the next shortest one. Keep on going until the whole stairway is done...
		(DO NOT GIVE ASSISTANCE EVEN IF THE INSTRUCTIONS ARE NOT FOLLOWED.)
CORRECT ORDER AFTER SCORING.		
SHOW CHILD WITH THE FIRST BLOCK ON TOP OF 2ND BLOCK HOW TWO BLOCKS CAN BE MADE.		These blocks are special. We can cut the second block (POINT) into two blocks like the first one. See?... (DEMONSTRATE)
		We can cut the third block (POINT) into three blocks like the first one.
(#5, 7, 10)	2.	How many blocks like the first one (POINT) can you make out of the 5th block (POINT)?
		REPEAT QUESTION FOR #7, 10 BLOCKS.
DO NOT ALLOW CHILD TO MEASURE WITH BLOCKS. SUGGEST THAT HE TRY ANOTHER WAY.	3.	How many blocks like the first one can we make out of this one (POINT TO #6, THEN #9)?...
DISARRANGE BLOCKS. PLACE GUIDE STICK UNDER BLOCKS TO EVEN THE BOTTOM SIDE.	4.	Remember the way the stairway was before?... You can move the blocks around if you want to. How many little blocks like the first one can we make out of this block (POINT TO #3)?...

(CHILD IS OBLIGED TO RE-
CONSTRUCT MENTALLY OR
OTHERWISE BEFORE REPLYING.)

REPEAT QUESTION WITH #7, 6, 8, and 10.

Test Log: Cardination

Tape: Number______ Side________ Meter Number_______ Date:____________________

Subject No.______ Group________ School_______________ E____________ O____________

Starting Time________________ Finishing Time________________ Total Time________________

1.	Make stairway	P	F	# errors_______
2.	How many in 5th	P	F	
	How many in 7th	P	F	
	How many in 10th	P	F	
3.	How many in #6	P	F	
	How many in #9	P	F	
4.	Disarrange. How many in #3	P	F	
	" " " " #7	P	F	
	" " " " #6	P	F	
	" " " " #8	P	F	
	" " " " #10	P	F	

Appendix I

Test: Additive Composition of Classes I

Materials needed: 15 one inch squares of red felt
7 one inch squares of blue felt
1 can

Procedures:		**Instructions and Questions**
PRESENT 3 RED FELT SQUARES AND 7 BLUE FELT SQUARES.	1.	Here are some cloth squares. Some are red and some are blue. Are the blue squares cloth?
	2.	Are the red squares cloth?
	3.	Are there the same number of blue squares as there are cloth squares, or are there more blue squares or more cloth squares?
	4.	If we made a row of all the cloth squares, and then made a row of all the blue squares, which row would be longer?
PRESENT 12 EXTRA RED SQUARES.	5.	Here are some more red squares. Now there are more red squares than there are blue squares. Are there more red squares or more cloth squares?
	6.	Are there more cloth squares or more blue squares?
REMOVE 12 EXTRA RED SQUARES.	7.	Now are there more cloth squares or more blue squares?
PRESENT CAN.	8.	If we put all the cloth squares in this can, would there be any squares left outside?
	9.	If we put all the blue squares inside this can, would there be any squares left outside?

10. Are the blue squares cloth?

11. Are the red squares cloth?

12. Are there more cloth squares or more blue squares?

13. If we put them into a row, which would be longer, a row of cloth squares, or a row of blue squares?

Test Log: Additive Composition of Classes I

Tape: Number_______ Side_______ Meter Number_______ Date:____________________

Subject No.______ Group________ School________________ E__________ O__________

Starting Time_______________ Finishing Time_____________ Total Time_______________

1.	Q.	Are blue cloth?	Yes	No
2.	Q.	Are red cloth?	Yes	No
3.	Q.	More blue or cloth squares?	P	F
4.	Q.	Row; which longer?	P	F
5.	Add 12 red.			
	Q.	More red or cloth squares?	P	F
6.	Q.	More blue or cloth squares?	P	F
7.	Remove 12 red.			
	Q.	More blue or cloth?	P	F

8.	Q.	Cloth squares outside can?	P	F
9.	Q.	Squares outside can?	P	F
10.	Q.	Are blue cloth?	Yes	No
11.	Q.	Are red cloth?	Yes	No
12.	Q.	More cloth or blue squares?	P	F
13.	Q.	Row; which longer?	P	F

Appendix J

Test: Additive Composition of Classes II

Materials needed: Drawings of children, one having 2 girls and 5 boys, the other having 10 girls; drawing of a school

Procedures:		Instructions and Questions
PRESENT DRAWING OF 2 GIRLS AND 5 BOYS.		Here are some children; some are boys and some are girls.
	1.	Are the boys children?
	2.	Are the girls children?
	3.	Are there the same number of boys as there are children?
	3a.	Are there more boys or more children?
	4.	If we made a row of all the children, and then made a row of all the boys, which row would be longer?
PRESENT DRAWING OF 10 EXTRA GIRLS.	5.	Here are some more girls. Now there are more girls than there are boys. Are there more girls or more children?
	6.	Are there more children or more boys?
REMOVE DRAWING OF 10 EXTRA GIRLS.	7.	Now are there more children or more boys?
	8.	If we put all the children into this school, would there be any boys or girls left outside?
	9.	If we put all the boys into this school would there be any children left outside?

10. Are the boys children?

11. Are the girls children?

12. Are there more children or more boys?

13. If we put them in a row, which would be longer, a row of children or a row of boys?

Test Log: Additive Composition of Classes II

Tape: Number_______ Side_______ Meter Number_______ Date:_______________________

Subject No.______ Group________ School_______________ E__________ O__________

Starting Time__________________ Finishing Time_____________ Total Time______________

1.	Q.	Are boys children	Yes	No
2.	Q.	Are girls children	Yes	No
3.	Q.	Same number boys as children	Yes	No
3a.	Q.	More boys or children	P	F
4.	Q.	Row; which longer	P	F
5.	Add 10 girls			
	Q.	More girls or children	P	F
6.	Q.	More children or boys	P	F

7.	Remove 10 girls		
	Q. More children or boys	P	F
8.	Q. Boys or girls outside school	P	F
9.	Q. Children outside school	P	F
10.	Q. Are boys children	P	F
11.	Q. Are girls children	P	F
12.	Q. More children or boys	P	F
13.	Q. Row; which longer	P	F

Appendix K

Training: Discontinuous Quantity Conservation

Part I

Materials needed: 6 wooden boxes, 30 erasers

CYCLE I

E AND CHILD HAVE IDENTICAL BOXES AND ERASERS.		Here are two boxes, they are just as big, see. Here is one for you and one for me. And here are some erasers for us. Let's fill the boxes with erasers. When I put one in mine, you put one in yours, okay? Like this... (DEMONSTRATE) Very good!
	Phase	
ESTABLISH EQUIVALENCE.	1.	Now do we both have the same number of erasers or does one of us have more?... How can you tell?
PRESENT ANOTHER BOX (OR OTHER BOXES).	2.	Here is another box (are other boxes). If we put all of your erasers in this (these) box(es), will you still have the same number of erasers as I have here or will one of us have more? (Who will have more?...) How can you tell?
DUMP CHILD'S ERASERS INTO OTHER BOX.	3.	Do we still have the same number of erasers or does one of us have more?... (Who has more?...) How can you tell?
POINT TO BOX IN WHICH CHILD'S ERASERS ORIGINALLY WERE.	4.	If we put them back in this box, will they fill it like mine?... Will we have the same number of erasers or will one of us have more?... How can you tell?

		Okay, let's see if you're right. Put them back in the box so we can check. Put them in, one at a time, just like you did before. Just like mine.
WHEN CHILD HAS PUT ALL 10 ERASERS IN SMALL BOX...	5.	Now do we have the same number or does one of us have more?... How can you tell?

IF CHILD PASSES PHASE 3 GO BACK TO PHASE 2 WITH ANOTHER BOX.
OTHERWISE GO TO CYCLE II WITH SAME BOX.

NOTE: AFTER THE FOURTH BOX, DIVIDE CHILD'S ERASERS INTO TWO OF THE FOUR BOXES AND REPEAT PHASES 2 THROUGH 5. THEN DIVIDE CHILD'S ERASERS INTO ALL FOUR BOXES AND REPEAT PHASES 2 THROUGH 5.

CYCLE II

((

IF CHILD FAILS PHASE 3

USE SAME BOX ON WHICH CHILD JUST FAILED.	6.	If we put your erasers in this (these) box(es), will you (I) have more?... How can you tell?
DUMP ERASERS BACK INTO FAILURE BOX.		Let's put them in here again.
	7.	Do we still have the same number of erasers or does one of us have more?... (Who has more?...) How can you tell?
IF CHILD ANSWERS "WE HAVE THE SAME NUMBER OF ERASERS" FOR PHASE 7, RETURN TO CYCLE I, PHASE 4.		

))

IF CHILD SAID HE HAS MORE, GO TO CYCLE IIA.

IF CHILD SAID E HAS MORE, GO TO CYCLE IIB.

CYCLE IIA

((

NOTE: CHILD SAID HE HAS MORE ERASERS.

ASK CHILD:	1a.	Did we take any erasers out of my box?... Did we put any more erasers in yours?
ALLOW TIME FOR CHILD TO ADJUST ERASERS UNTIL HE THINKS HE HAS THE SAME NUMBER.	2a.	Make them the same number as mine. Take out the extra ones. Count them as you take them out... Now do we have the same number of erasers or does one of us have more?
HAND CHILD THE SMALL BOX AGAIN (SAME SIZE AS E'S).	3a.	If we put your erasers back in your little box will your erasers cover the bottom of the box like mine do?
HAVE CHILD PUT ERASERS BACK ONE BY ONE.	4a.	Let's put your erasers back into your little box one at a time to check. Do they cover the bottom of your box like mine?... Do we have the same number of erasers or does one of us have more?... What happened?
HAVE CHILD PUT BACK THE ERASERS HE TOOK OUT.		Count the ones you took out. Now see how many erasers it will take to cover the bottom of your box... See, you had to use all the erasers you took out to cover the bottom of your box like mine.

5a. With the erasers you took away back in your box, do we both have the same number of erasers or does one of us have more?... How can you tell?

That's right, if we put back the erasers you took away, we have the same number of erasers. When the bottom of both boxes is covered we know we have the same number of erasers.

))

GO BACK TO PHASE 2, CYCLE I WITH A NEW BOX.

CYCLE IIB

((

NOTE: CHILD SAID E HAS MORE ERASERS.

ASK CHILD:	1b.	Did we take any out of your box?... Did we put any more in mine?
GIVE CHILD EXTRA ERASERS, AND ALLOW TIME FOR CHILD TO ADJUST ERASERS UNTIL HE THINKS HE HAS SAME NUMBER. MAKE SURE CHILD KEEPS TRACK OF ADDED ONES.	2b.	Make them the same number as mine. Here are some extra erasers. Let's count them as you put them in... Now do we have the same number or does one of us have more?
HAND CHILD THE SMALL BOX (SAME SIZE AS E'S).	3b.	If we put your erasers back in your little box, will your erasers cover the bottom of your box like mine do?

HAVE CHILD PUT ERASERS BACK ONE BY ONE.	4b.	Let's put your erasers back into your little box one at a time to check. Do they cover the bottom of your box like mine?... Do we have the same number of erasers or does one of us have more?... What happened? Why won't they all go in?... How many erasers won't go in?... That is the same number of extra ones you put in!
	5b.	If we take away all the extra ones you put in, will we have the same number of erasers or will one of us have more?... How can you tell? That's right, if we take away the extra ones you put in, we'll have the same number of erasers. When the bottom of both boxes is covered we know we have the same number of erasers.

))

GO BACK TO PHASE 2, CYCLE I WITH A NEW BOX.

Part II

Materials needed: 2 small identical cans, 4 larger different size cans, 34 sticks of 2 colors

CYCLE I

E AND CHILD HAVE IDENTICAL CANS AND STICKS.	Here are two cans, they are just as big, see... Here is one for you and one for me. And here are some sticks for us. Let's fill the cans with sticks. When I put one in mine you put one in yours, okay? Like this... (DEMONSTRATE AND CONTINUE UNTIL CANS ARE FILLED)... Very Good!

	Phase	
ESTABLISH EQUIVALENCE.	1.	Now do we both have the same number of sticks or does one of us have more?... How can you tell?
PUT RUBBER BAND AROUND BOTH SETS OF STICKS.		I'll put a rubber band around mine so that I won't lose any... Let's put a rubber band around yours.
PRESENT ANOTHER CAN (OR OTHER CANS).	2.	Here is another can (are other cans). If we put all of your sticks in this (these) can(s), will you still have the same number of sticks as I have here or will one of us have more?... (Who will have more?...) How can you tell?
REMOVE RUBBER BAND AND PUT CHILD'S STICKS INTO OTHER CAN.	3.	Do we still have the same number of sticks or does one of us have more?... How can you tell?
POINT TO CAN IN WHICH CHILD'S STICKS ORIGINALLY WERE.	4.	If we put them back in this can, will they fill it like mine?... Will we have the same number of sticks or will one of us have more?... How can you tell?
PLACE RUBBER BAND AROUND CHILD'S STICKS.		You hold the sticks and I'll put a rubber band around them so you won't lose any... Now put them back in the can so we can check to see if you are right.
WHEN CHILD HAS PUT ALL STICKS IN SMALL CAN...	5.	Now do we have the same number of sticks or does one of us have more?... How can you tell?

AFTER PHASE 5 IF CHILD PASSED PHASE 3, GO BACK TO PHASE 2 WITH ANOTHER CAN.
IF CHILD FAILED PHASE 3, GO TO CYCLE II WITH SAME CAN.

NOTE: AFTER THE FOURTH CAN, DIVIDE CHILD'S STICKS INTO TWO OF THE FOUR CANS AND REPEAT PHASES 2 THROUGH 5. THEN DIVIDE CHILD'S STICKS INTO ALL FOUR CANS AND REPEAT PHASES 2 THROUGH 5.

CYCLE II

((

IF CHILD FAILS PHASE 3

USE SAME CAN(S) ON WHICH CHILD JUST FAILED.	6.	If we put your sticks in this (these) can(s), will you (I) have more?... How can you tell?
REMOVE BAND AND PUT CHILD'S STICKS INTO THE FAILURE CAN(S).		Let's take off the rubber band and put your sticks in this can again.

	7.	Do we still have the same number of sticks or does one of us have more? (Who has more?...) How can you tell?
IF CHILD ANSWERS, "WE HAVE THE SAME NUMBER," FOR PHASE 7, RETURN TO CYCLE I, PHASE 4.		

))

IF CHILD SAID HE HAS MORE, GO TO CYCLE IIA.

IF CHILD SAID E HAS MORE, GO TO CYCLE IIB.

CYCLE IIA

((

NOTE: CHILD SAID HE HAS MORE STICKS.

ASK CHILD:	1a.	Did we take any sticks out of my can?... Did we put any more sticks in yours?
ALLOW TIME FOR CHILD TO ADJUST STICKS UNTIL HE THINKS HE HAS SAME NUMBER.	2a.	Make them the same number as mine. Take out the extra ones. Count them as you take them out... Now do we have the same number of sticks or does one of us have more?
HAND CHILD THE SMALL CAN AGAIN (SAME SIZE AS E'S).	3a.	If we put your sticks back in your little can, will your sticks fill it like mine do?
PLACE RUBBER BAND AROUND CHILD'S STICKS AND PUT THEM BACK IN HIS SMALL CAN.	4a.	Let's put a rubber band around them so you won't lose any and put them back into your little can to check. Do they fill your can like mine?... Do we have the same number of sticks or does one of us have more?... What happened?
HAVE CHILD PUT BACK THE STICKS HE TOOK OUT.		Count the ones you took out... Now see how many sticks it will take to fill your can... See, you had to use all the sticks you took out to fill your can like mine.
	5a.	With the sticks you took away back in your can, do we both have the same number of sticks or does one of us have more?... How can you tell?
		That's right, if we put back the sticks you took away, we have the same number of sticks. When your can is full like mine, we know we have the same number of sticks.

))

GO BACK TO PHASE 2, CYCLE I, WITH A NEW CAN.

CYCLE IIB

((

NOTE: CHILD SAID E HAS MORE STICKS.

ASK CHILD:	1b.	Did we take any out of your can?... Did we put any more in mine?
GIVE CHILD EXTRA STICKS AND ALLOW TIME FOR CHILD TO ADJUST STICKS UNTIL HE THINKS HE HAS THE SAME NUMBER. MAKE SURE CHILD KEEPS TRACK OF ADDED ONES.	2b.	Make them the same number as mine. Here are some extra sticks. Let's count them as you put them in... Now do we have the same number or does one of us have more?
HAND CHILD THE SMALL CAN (SAME SIZE AS E'S).	3b.	If we put your sticks back in your little can, will your sticks fill it like mine do?
PLACE RUBBER BAND AROUND CHILD'S STICKS AND PUT THEM BACK IN HIS LITTLE CAN.	4b.	Let's put a rubber band around them so you won't lose any and put them back into your little can to check. Do they fill your can like mine do?... Do we have the same number of sticks or does one of us have more?... What happened? Why won't they all go in?... How many sticks won't go in?... That is the same number of extra ones you put in!

5b. If we take away all the extra ones you put in, will we have the same number of sticks or will one of us have more?... How can you tell?

That's right, if we take away all the extra ones you put in, we will have the same number of sticks. When your can is full like mine, we know we have the same number of sticks.

))

GO BACK TO PHASE 2, CYCLE I WITH A NEW CAN.

Training Log: Discontinuous Quantity

Tape: Number_______ Side_______ Meter Number_______ Date:______________________

Subject No.______ Group________ School________________ E__________ O__________

Starting Time_________________ Finishing Time________________ Total Time_____________

Part I (Erasers and Boxes) _______

Part II (Sticks and Cans) _______

1. Equivalence? P F

Reason:

2. Prediction on Box/Can #__________ P F

Reason:

3. Equal? P F
Reason:

4. Reversal. Prediction: P F
Same or more P F
Reason:

5. Equivalence? P F
Reason:

IF FAIL

6. Prediction: P F
7. Equal? P F
Who has more E S
1a. (1b.) Take any out Yes No
Put any in Yes No

2a. (2b.) Take out/put in Yes No
#________
3a. (3b.) Prediction (Equal) Yes No
4a. (4b.) Equal Yes No
Reason:

5a. (5b.) Equal Yes No
Reason:

(Observer's comment:)

Appendix L

Training: Correspondence I

Materials needed: A quantity of 35 mm. cans and caps

For Task I, II, III, and IV see page following procedures.

Use entire procedure for each situation below on Tasks I, II, III, and IV.

The Situations	Failure Steps
1. Caps closer together than cans.	1a. Caps closer together, can removed.
2. Caps farther apart than cans.	2a. Caps farther apart, can added.
3. Caps closer together than cans.	3a. Caps closer together, cap added.
4. Caps farther apart than cans.	4a. Caps farther apart, cap removed.

Procedures:	Phase	Instructions and Questions
PRESENT CAPS AND CANS ACCORDING TO SITUATION. HAVE CHILD PLACE A CAP ON EACH CAN, THEN REMOVE REMAINING CAPS AND CANS.		Here are some caps and cans. Let's put a cap on each can. Are there the same number of caps and cans or are there more caps or more cans?... Why?... Okay, now watch what I do.
REMOVE CAPS AND PLACE IN FRONT OF CANS ACCORDING TO THE PROPER SITUATION.	1.	Are there still the same number of caps and cans, or are there more caps or more cans?... How can you tell?... (IF FAIL: Which are there more of?...)

REVERSE OPERATION. HAVE CHILD PUT A CAP ON EACH CAN.		Let's check and see if you're right. Let's put them back on the cans and see...
	2.	Now are they the same or are there more caps or more cans?...

IF CHILD PASSES PHASE 1, START OVER WITH NEXT SITUATION;

IF CHILD FAILS PHASE 1, CONTINUE WITH FAILURE STEP FOR EACH SITUATION.

((

IF CHILD FAILS: REPEAT SAME SITUATION.		
REMOVE CAPS AND PLACE AS BEFORE.	a.	Okay, now watch what I do... Are there the same number of caps and cans, or are there more caps or more cans?
IF CHILD PASSES, GO TO NEXT SITUATION; BEGIN AT PHASE 1.		
IF CHILD FAILS 1a:		Which are there more of?... How can you tell?
IF CHILD FAILS 1 OR SITUATION 4:		Take away the extra (cans/caps).
IF CHILD FAILS SITUATION 2 OR 3:		Put in the extra (cans/caps).
	b.	Now can you cover all these cans with these caps, or will there be some cans or caps left over?...
	c.	Put them on and see. Do you have the same number of caps and cans?...

Look! You have more (caps/cans) than you have (caps/cans)! How did that happen?...

IF CHILD DOESN'T KNOW:

How many (cans/caps) are left over?... How many (cans/caps) did you (take away/put in)?...

Oh! They are the same number!

))

Did this happen because you (took away/put in) some (cans/caps)?...

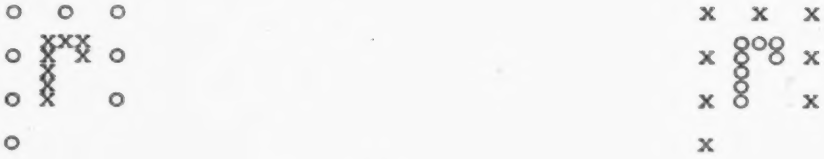
Put them back and see. (Take it/them back out and see.)

The number of (cans/caps) that you (took away/put in) is the same as the number of (caps/cans) that was left over!

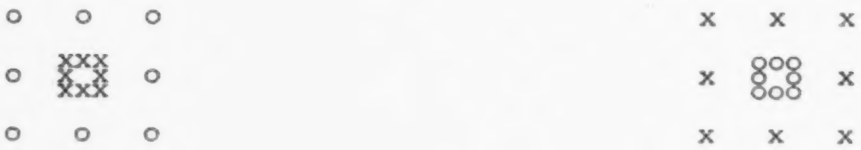
GO THROUGH EACH TASK, USING ALL FOUR SITUATIONS. CANS = o CAPS = x

	Caps closer together	Caps farther apart
Task I in a straight line:		
	o o o o o o o o	x x x x x x x x
	x x x x x x x x	o o o o o o o o

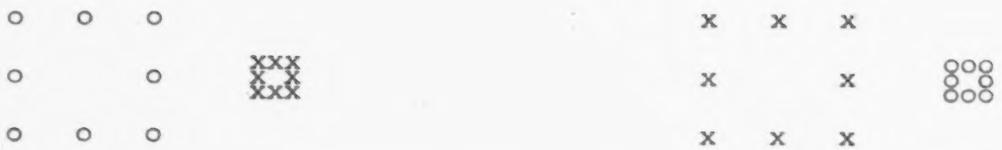
Task II in an open rectangle:



Task III in a square:



Task IV square removed:



Training Log: Correspondence I

Tape: Number_______ Side_______ Meter Number_______ Date:____________________

Subject No.______ Group________ School_________________ E__________ O__________

Starting Time________________ Finishing Time_______________ Total Time_______________

Situation 1:

1. Caps closer together		
Equal?	P	F
(F) Which is more?	caps	cans
2. Reversal equivalence	P	F

Situation 2:

1. Caps farther apart		
Equal?	P	F
(F) Which is more?	caps	cans
2. Reversal equivalence	P	F

Situation 3:

1. Caps closer together		
Equal?	P	F
(F) Which is more?	caps	cans
2. Reversal equivalence	P	F

Failure for Situation 1:

a. Caps together again		
Equal?	P	F
(F) Which is more?	caps	cans
# taken away/added	____	____
b. Prediction	P	F
c. Reversal equivalence	P	F

Failure for Situation 2:

a. Caps apart again		
Equal?	P	F
(F) Which is more?	caps	cans
# taken away/added	____	____
b. Prediction	P	F
c. Reversal equivalence	P	F

Failure for Situation 3:

a. Caps together again		
Equal?	P	F
(F) Which is more?	caps	cans
# taken away/added	____	____

Situation 4:

1. Caps farther apart

Equal?	P	F
(F) Which is more?	caps	cans

2. Reversal equivalence P F

Failure for Sit. 3, cont'd.

b. Prediction	P	F
c. Reversal equivalence	P	F

Failure for Situation 4:

a. Caps apart again

Equal?	P	F
(F) Which is more?	caps	cans
# taken away/added	____	____
b. Prediction	P	F
c. Reversal equivalence	P	F

Appendix M

Training: Correspondence II

Materials needed: A quantity of 35 mm. cans with caps

Begin with Task 1 and continue through Task 10 (see page following procedures). Use the entire procedure for each task.

Procedures:	Phase	Instructions and Questions
PRESENT CANS.	1.	How many cans do I have here?...
((		
IF CHILD FAILS.	1a.	Let me hear you count them...
DEMONSTRATE BY SLIDING ONE CAN OVER TO THE SIDE, THEN PUTTING IT BACK.		Move each can over here when you count it.
))		
		Good! There are ___ cans.
SLIDE CANS BACK INTO THEIR ORIGINAL SHAPE.		Now you take the same number of caps from your pile, and make the same thing I made...
	2.	How many caps do you have?
((		
IF CHILD FAILS.	2a.	Count them out loud to me...

DEMONSTRATE BY SLIDING ONE CAN OVER AND PUTTING IT BACK.

Move them over here when you count them.

))

Very good! You have ____.

3. Do we have the same number of caps and cans, or does one of us have more?

((

IF CHILD FAILS, ENCOURAGE HIM TO PLACE CAPS ON CANS.

3a. Let's check. Let's put one of your caps on each of my cans...

Do we have the same number or does one of us have more?

))

PLACE THEM BACK ON THE TABLE IN THEIR ORIGINAL POSITION.

Now let's put them back again...

4. Now do we have the same number or does one of us have more?...

Good.

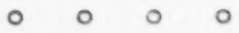
5. How do you know we have the same number?

AFTER COMPLETING TASK 1, REPEAT THE SAME PROCEDURE WITH THE FOLLOWING TASKS (2 THROUGH 10):

Correspondence Construction Series

Task

1.



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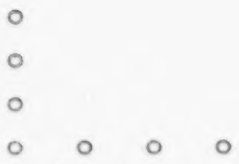

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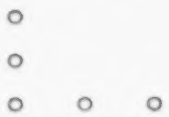
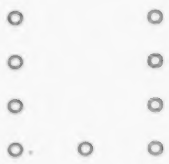


(5)

Task

4.



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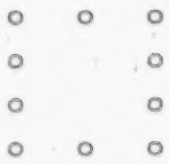

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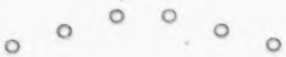
6.



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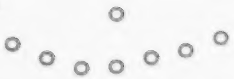
Task

7.



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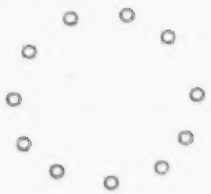

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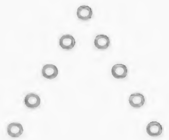
9.



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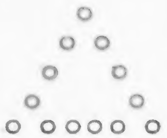
10.



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Training Log: Correspondence II

Tape: Number______ Side______ Meter Number______ Date:______________

Subject No.______ Group________ School______________ E__________ O__________

Starting Time____________ Finishing Time____________ Total Time____________

Fig.	Question			Fig.	Question			Fig.	Question		
1.1		P	F	5.1		P	F	8.1		P	F
1.2		P	F	5.2		P	F	8.2		P	F
1.3		P	F	5.3		P	F	8.3		P	F
1.4		P	F	5.4		P	F	8.4		P	F
1.5	reason:			5.5	reason:			8.5	reason:		
2.1		P	F	6.1		P	F	9.1		P	F
2.2		P	F	6.2		P	F	9.2		P	F
2.3		P	F	6.3		P	F	9.3		P	F
2.4		P	F	6.4		P	F	9.4		P	F
2.5	reason:			6.5	reason:			9.5	reason:		
3.1		P	F								
3.2		P	F	7.1		P	F	10.1		P	F
3.3		P	F	7.2		P	F	10.2		P	F
3.4		P	F	7.3		P	F	10.3		P	F
3.5	reason:			7.4		P	F	10.4		P	F
				7.5	reason:			10.5	reason:		
4.1		P	F								
4.2		P	F								
4.3		P	F								
4.4		P	F								
4.5	reason:										

Appendix N

Training: Continuous Quantity

Materials needed: Quantity of colored water (pop); sand; glass beakers of varying size

Two 600 ml. beakers
One 150 x 75 ml. dish
Two 250 ml. beakers
Four 150 ml. beakers

Procedures:	Phase	Instructions and Questions
TWO 600 ml. BEAKERS AND "POP" (SAND).		Here are two glass jars and here is some pop (sand). It is not real pop, but we will pretend it is. Okay? Let's pour the pop (sand) in these glass jars.
ESTABLISH EQUIVALENCE BY POURING AN EQUAL AMOUNT OF "POP" (SAND) IN BOTH BEAKERS.	1.	One is for you and one is for me. Do we both have the same amount of pop (sand) or does one of us have more?... (IF MORE:) Make them so that we have the same amount of pop (sand).
PRESENT THE FOLLOWING IN SUCCESSION AND CARRY OUT COMPLETE PROCEDURE WITH EACH. 1. 150 x 75 ml. dish 2. two 250's 3. one 250, two 150's 4. four 150's 5. one 150, one 250, one 600, and one 150 x 75	2.	Here is (are) another (other) jar(s). If we put your pop (sand) in this (these) jar(s) will you still have the same amount of pop (sand) as I do?... How can you tell?

POUR "POP" (SAND) INTO THE OTHER BEAKER(S).	3. Do you still have the same amount of pop (sand) as I do or does one of us have more?... (IF NOT: Who has more?... How can you tell?)
	4. If we put your pop (sand) back in the jar like mine will we have the same amount or will one of us have more?... (IF MORE: Who will have more?)
	Pour it back so we can check...
E POURS BACK (150 x 75) INTO 600 ml. CHILD CAN POUR OTHERS.	5. Do we have the same amount of pop (sand) now?

AFTER PHASE 5 IF CHILD PASSED PHASE 3, GO BACK TO PHASE 2 WITH NEXT BEAKER.

IF CHILD FAILED PHASE 3, GO TO PHASE 6 WITH SAME BEAKER.

((

IF CHILD FAILED USE SAME BEAKER(S).	6. If we put it in this (these) again will I/you have more?... How can you tell?
POUR BACK INTO FAILURE BEAKER(S).	Let's put it back and see...
	7. Do you have the same amount of pop (sand) as I do or does one of us have more?... How can you tell?
IF CHILD ANSWERS, "WE HAVE THE SAME AMOUNT," FOR PHASE 7, RETURN TO PHASE 4.	
IF CHILD FAILS PHASE 7:	8. Who has more? (E OR CHILD)
IF CHILD SAYS E HAS MORE:	Did we pour it all in your jar?...

IF CHILD SAYS HE HAS MORE:		Did we pour any extra in your jar?...
		Make them the same. Take out the extra pop (sand) so that we'll have the same amount of pop (sand).
USE SMALLER BEAKER AS DIPPER. USE ANOTHER 600 ml. FOR EXTRA "POP" (SAND).		Put the extra pop (sand) in this jar.
	9.	Now do we both have the same amount of pop (sand)?... We'll put this extra over here. We can't count that now.
INDICATE ORIGINAL 600 ml. BEAKER.	10.	If we put it back in the jar like this one will we still have the same or will one of us have more?... How can you tell?
		Let's put it in and check.
POUR "POP" (SAND) INTO 600 ml. BEAKER.	11.	Did we pour it all in?... Do we now have the same? How can you tell?
		If you put back some of the pop (sand) you took out will we have the same amount or will one of use have more? See how much you have to put in to make them the same amount.
HAVE CHILD POUR EXTRA "POP" (SAND) BACK.	12.	See you put it all back. Now do we have the same amount of pop (sand)?

))

	Very good. You are right. We have the same amount of pop.
GO BACK TO PHASE 2 AND REPEAT THE PROCEDURE USING NEXT BEAKERS.	

Training Log: Continuous Quantity

Tape: Number______ Side______ Meter Number______ Date:____________________

Subject No._____ Group_______ School____________ E_________ O_________

Starting Time______________ Finishing Time_____________ Total Time___________

Pop and Beakers _________

Sand and Beakers _________

					If Fail		
1.	Equivalence? Reason:	P	F	6.	Prediction:	P	F
2.	Prediction on Beaker #____ Reason:	P	F	7.	Equal? Reason:	P	F
3.	Equal? Reason:	P	F	8.	Who has more? #______	E	S
4.	Reversal. Prediction:	P	F	9.	Equal?	P	F
	Who has more?	E	S	10.	Prediction: Reason:	P	F
5.	Equivalence? Reason:	P	F	11.	Equal? Reason:	P	F
(Observer's comment:)				12.	Extra Equal?	P	F

Appendix O

Training: Ordination

Materials needed: Zerbils, doors, and door stand

Procedures:	Phase	Instructions and Questions
PLACE THE CHILD TO THE SIDE OF E. PRESENT ZERBILS 1, 4, 7, 9, 10.		Here are some funny looking people. They are called Zerbils. Each has only one eye; they must always walk in a straight line. That way they will be able to see if there is danger ahead.
	1.	Put them in a line so the smallest one is first, then the next smallest, and so on. Remember, each Zerbil must be able to see over the head of one in front of him. Only when they walk in a line from smallest to tallest, can each Zerbil see over the others.

((

IF CHILD FAILS:	1a.	Is this one the smallest?... (#1)
COMPARE #1 TO ALL OTHERS BY STANDING IT NEXT TO EACH.		Let's check... Good, it is the smallest. Then put it here.
	1b.	Which is smallest of these?... (REMAINING ZERBILS.)

IF WRONG, HAVE CHILD COMPARE HIS INCORRECT CHOICE TO EACH OF REMAINING ZERBILS.		Is it smaller than this?... (TO EACH ZERBIL IN HIS ROW.) Is it taller than this one?... (#1 OR LAST IN CORRECTED ROW.)

Good! Since it's smaller than all these, (HIS ROW) and just taller than this one (LAST IN CORRECTED ROW), we must put it here.

RETURN TO #1b UNTIL ALL ERRORS ARE CORRECTED.

))

PRESENT REMAINING ZERBILS, #2, 5, 6, AND 8.

2. These Zerbils want to walk with the others. Remember, they also need to be able to see as they walk along. Can you put them in line where they belong?...

((

IF ZERBILS ARE MISPLACED IN THE SERIES, AND ONE IS TALLER THAN THE ONE BEHIND IT, POINT TO TALLER AND ASK:

2a. Is this Zerbil smaller than the one behind/in back of it?... Then can this Zerbil (THE SHORTER ONE BEHIND) see over the head of this one? (THE TALLER IN FRONT.)

IF CHILD FAILS, HELP HIM PUT ZERBILS IN PLACE.

Let's change it so that the taller Zerbil is in back/behind it, and the smaller Zerbil is in front. This way both of them can see.

REPEAT PROCEDURE UNTIL SERIES IS CORRECT.

))

Good! Now all Zerbils can see in front of each other.

MOVE ZERBIL TO THE RIGHT, KEEPING THEM IN ORDER.		Now the Zerbils have gone for a walk.
	3.	Now these Zerbils live in houses that we can't see, but we can see their front doors.
PRESENT DOORS.		Here are the doors to the houses the Zerbils live in. Put them in a row like you did the Zerbils, with the smallest one first, so that each Zerbil can quickly find his home.
PRESENT STRAIGHT EDGE.		Use this to make sure they're in a straight line.

((

IF CHILD FAILS, POINT TO THE FIRST DOOR IN HIS ROW.	3a.	Is this the smallest door?

COMPARE IT WITH EACH FOLLOWING DOOR UNTIL YOU COME TO A SMALLER DOOR. REPEAT WITH FIRST UNTIL NO OTHER SMALLER DOORS ARE FOUND.		Let's check. Is it smaller than this?... (TO EACH DOOR.) Oh! This door is smaller! Then this should be the first door.

NOW POINT TO THE FIRST DOOR IN THE SERIES THAT IS SHORTER THAN THE DOOR IN FRONT OF IT. REPEAT QUESTION UNTIL THERE ARE NO MORE TALLER DOORS IN FRONT OF IT.	3b.	Is this (SHORTER ONE) door taller than this? (IN FRONT.) No? Then it must go in front of it...
REPEAT ABOVE FOR EACH DOOR OUT OF PLACE, UNTIL ENTIRE SERIES IS CORRECT.		

))

PLACE DOORS IN THE STAND AND MOVE THEM TO THE LEFT.		I'll put the doors in this stand, so that the Zerbils can find them.
	4.	Now the Zerbils are ready to come back from their walk. Let's turn them around so they are walking back.
SET STAND SUCH THAT THE DOOR SERIES IS REVERSED TO THE ZERBILS WALKING BACK.		Put the smallest one here, in front. Remember, each Zerbil must be able to see over the head of the one in front of him.

(((

IF CHILD FAILS:	4a.	Are they all facing home?...
(IF ANY ARE FACING BACKWARDS:)		(Is this one facing home?...)
REFER TO EACH ZERBIL THAT IS SHORTER THAN THE ONE IN FRONT OF IT.		Now can this one see over the head of the one in front of him?... No? Then we must move him, so that he can see.

)))

		Very good! Now they can all see their way home.
REPEAT FOR ALL IN THIS ORDER: 2, 4, 9, 1, 6, 8, 7, 5, 3, 10.	5.	The Zerbils are very tired from their walk. Can you show me which Zerbil will walk into this door?... (#2). Point to the Zerbil that goes with this door. (#4, 9, 1, 6, 8, 7, 5, 3, 10).

(((

IF CHILD FAILS:	5a.	We can number the Zerbils from smallest to tallest. The smallest Zerbil is #1, the next smallest is #2, and so on. We can also number the doors from smallest to tallest. The smallest door is #1 and the next smallest door is #2, and so on.

Now the smallest, or #1, Zerbil goes in the smallest, or #1, door, okay? Remember, the number of the Zerbil should be the same as the number of the door. Well then, point to the Zerbil which goes into this door... What number is that Zerbil?

IF CHILD STILL FAILS:

5b. Which number door is this? Remember, the smallest door is #1. Count them out loud with me up to this. 1, 2 ... Good, this is door #___. Now count the Zerbils out loud with me from smallest to tallest until you get to the same number. 1, 2 ... Good, then this Zerbil goes into the door with the same number.

(AFTER CHILD SELECTS CORRECT ZERBIL GO BACK TO PHASE 5 UNTIL COMPLETE.)

))

Very good!

REMOVE DOORS 7 - 10.
REMOVE ZERBILS 7 - 10.

These Zerbils have gone on a camping trip. And they've taken their doors with them. While they are gone, the others will play.

DISARRANGE ZERBILS.

Now we want to help these Zerbils find their own doors.

One way to help them is to put the Zerbils in a line like their doors, from smallest to tallest. Which Zerbil is smallest?... It goes in the smallest door. Which Zerbil is tallest?... It goes in the tallest door.

Remember now, we can give each Zerbil a number. The smallest Zerbil will be number 1. Which Zerbil is #2?... #3?... #4?... #5?... #6?

((

IF CHILD FAILS REARRANGE THE ZERBILS AGAIN AND AGAIN BEFORE HAVING CHILD COUNT.

Count the Zerbils from smallest to tallest.

))

DISARRANGE ZERBILS.

6. Let's see if you can help the Zerbils find their own doors all by yourself. Try to get the right one the first time. Okay?

Which Zerbil will go into this door?... (#2, 4, 1, 6, 5, 3)

((

IF CHILD FAILS, LINE ZERBILS UP AND REPEAT THE COUNTING PROCEDURE.

6a. Which door am I pointing to?... Count and see... Which Zerbil will go in this door then?... Count them from smallest to tallest.

))

Very good!

Training Log: Ordination

Tape: Number_______ Side_______ Meter Number_______ Date:__________________

Subject No.______ Group________ School________________ E__________ O__________

Starting Time_________________ Finishing Time_____________ Total Time______________

		If Pass		If Fail
1.	Order Zerbils	P	F	
1a.	Correct errors			# errors
2.	Put in remainder	P	F	
2a.	Correct errors			# errors
3.	Order doors	P	F	
3a-b.	Correct errors			# errors
4.	Turning Zerbils around	P	F	
4a.	Correct errors			# errors

5. Matching Zerbils and doors:

#2	P	F	#_____
#4	P	F	#_____
#9	P	F	#_____
#1	P	F	#_____
#6	P	F	#_____
#8	P	F	#_____
#7	P	F	#_____
#5	P	F	#_____
#3	P	F	#_____
#10	P	F	#_____

6. Disarrangement:

#2	P	F
#4	P	F
#1	P	F
#6	P	F
#5	P	F
#3	P	F

Appendix P

Training: Cardination

Part I

Materials needed: 15 cubic inch blocks

Procedures:	Phase	Instructions and Questions
PRESENT CHILD WITH 15 CUBIC INCH BLOCKS TO MAKE FIVE "STEPS."		Here are some wooden blocks.
	1.	Build a stairway with these blocks, so that the first step is one block high, the second step is two blocks high, and so on.

((

IF CHILD FAILS, POINT OUT INDIVIDUAL STEPS FOR HIM.	1a.	Is this step one block higher than this step?... (REPEAT QUESTION FOR EACH ERROR.) Then make it one block higher...

))

	2.	How many steps are there in the stairway?...

((

IF CHILD FAILS: LET HIM BEGIN, PICK UP COUNTING WHERE HIS COUNTING FALTERS, POINTING TO EACH STAIR STEP AS YOU SAY THE NUMBER.	2a.	Let's count them together (POINTING). ...(four, five).

))

Good. There are five stair steps.

3. Now, how many blocks are used for the first step?... And how many blocks for the second step?... For the third?... And the fourth?... The fifth?

((

IF CHILD FAILS ANY OF THE STEPS, HELP BY POINTING TO THE INDIVIDUAL BLOCKS AND COUNTING THEM. SEPARATE, IF NECESSARY.

3a. Let's count them.

... (one, two, three).

))

POINT TO BLOCKS IN STEP 2 AND 3.

4. Which step has more blocks, this one (POINT TO #2) or this one (POINT TO #3)?

((

IF CHILD FAILS:

4a. Let's look at these two steps again. (POINT TO STEP 2.) How many blocks in this one? Count with me ... 1, 2. So there are 2 blocks in this one. (POINT TO STEP 3.) Now let's count the blocks in this step ... 1, 2, 3. So there are 3 blocks (POINT) in this step and 2 blocks (POINT) in the other. We know 3 is more than 2, so this step (POINT TO #3) has more blocks than this one (POINT).

))

5. How many more blocks are in the 3rd (POINT) step than are in the 2nd step (POINT)?

(POINT TO #3.) How many blocks do you need to take away from this one to make it the same as this one (POINT TO #2)?

(((

IF CHILD FAILS:

5a. If you take (CHILD'S NUMBER) blocks off from the third step, will it be the same size as the second step?...

Show me... No, they are not the same, are they?... Here, let's start over again. (PUT BLOCKS BACK). Take away only one block from the third step... Now are they the same?... Yes, of course, they are the same. So there is only one more block on the third step.

Okay, now put the extra block back on the third step again.

))

6. How many more blocks will we have to add to the third step (POINT) to make it the same as the fifth step (POINT)?

(((

IF CHILD FAILS, PRESENT HIM WITH THE NUMBER OF BLOCKS HE SUGGESTED. (IF HE HAS DIFFICULTY COMPARING, REMOVE THE FOURTH STEP TEMPORARILY).

6a. Let's add (CHILD'S NUMBER) blocks to the third step (POINT) and see... Is it as high as the fifth step now?...

What must we do to make them the same height?... (IF STILL INCORRECT, REPEAT).

REPLACE FOURTH STAIR STEP AGAIN.

Now how many blocks must we take away to make the third step the right height again?... Let's take them away and see...

))

Two blocks. Very good!

Part II

Materials needed: 10 strips of felt 1 x 1 to 1 x 10 inches,
additional pieces 1 x 1 and 1 x 3 inches,
wooden stick for base

REMOVE BLOCKS.

PRESENT FELT FOR FIRST 6 STEPS, AND STICK FOR BASE.		Now here are some pieces of felt which we can pretend are a stairway. (PRESENT STICK.) This will be the bottom of our stairway and we will build the steps on this.
		Let's see if you can make the stairway by laying these pieces side by side in a row from smallest to tallest until the stairway is finished.
	1.	Put them in a row, so that the smallest step comes first, and then the next smallest, and so on, until they make a stairway...

((

IF CHILD FAILS, POINT OUT EACH INDIVIDUAL MISTAKE, USING TWO FINGERS "WALKING" UP THE STAIRS.	1a.	If I want to walk up this stairway, will I go up with each step, or will I take a step down somewhere?... Where?... Fix the stairway so that I will always be going up...

))

AFTER STAIRWAY IS COMPLETE:	2.	Very good! Now, if we were to cut the 2nd step (POINT) into pieces, how many pieces could we make like this 1st step (POINT)?
PRESENT EXTRA PIECES AND SHOW THAT THEY ARE SAME AS STEP 1.		Here are some pieces of felt the same as the 1st step. See? (DEMONSTRATE.)

HAVE CHILD COVER THE 2nd STEP WITH EXTRA PIECES OF FELT.		Put these pieces, one at a time, over the 2nd step and see how many pieces it takes to cover the 2nd step.
		Now, how many pieces like the 1st step did it take to cover the 2nd step?... It took 2, didn't it?
	2R.	Then how many steps like the 1st step can we make if we cut up the 2nd step?

((

IF CHILD FAILS:	2a.	(POINT TO PIECES COVERING STEP 2). Remember, these pieces are the same size as this 1st step (POINT). See, it takes 2 of these pieces to cover the 2nd step (POINT). This means that we can cut the 2nd step into 2 pieces like the 1st step.

))

RAISE VOICE ON UNDERLINED WORDS.		Good! It takes 2 (USE 2 FINGERS TO SHOW CLEARLY) of the 1st step (POINT TO 1st) to make, or equal, the 2nd step (POINT TO 2nd).
MOVE EXTRA SQUARES FROM STEP 2, BUT LEAVE THEM WITHIN REACH OF THE CHILD.	3.	Now, tell me how many pieces like the 1st step (POINT) could we make if we cut up the 3rd step (POINT)?
POINT TO EXTRA SQUARES.		Use the smaller extra pieces of felt again and see how many pieces it takes to cover the 3rd step...
		Now, how many pieces did it take to cover the 3rd step?... It took 3, didn't it?

3R. Then how many steps like the 1st step (POINT) can we make if we cut up the 3rd step? (POINT.)

((

IF CHILD FAILS:

3a. (POINT TO PIECES COVERING STEP 3.) Remember these pieces are the same size as the 1st step (POINT). See, it takes 3 of these pieces to cover the 3rd step. That means we can cut the 3rd step into 3 pieces like the 1st step.

))

Very good, we can make 3 pieces like the 1st step when we cut the 3rd step.

RAISE VOICE ON UNDERLINED WORDS.

Now we know that the 2nd step can be cut into 2 pieces like the 1st step and the 3rd step can be cut into 3 pieces like the 1st step.

4. OK, we have talked about the 1st step, the 2nd step, and the 3rd step.

(POINT TO 6th.) Which step number is this?

((

IF CHILD FAILS:

4a. Let's count the steps together and see: 1, 2, 3, 4, 5, 6.

Good, this is the 6th step.

))

5. How many steps would I have to climb to get to the top of the stairs?...

USE 2 FINGERS IN A "WALKING MOTION" UP THE STAIRS.		Let's see if you're right. Count the steps with me as I point to them (POINT), 1, 2 ... 6. How many did we count?... That means I would have to climb 6 steps to get to the top of the stairs, doesn't it?
	6.	(POINT TO STEP #6). And, if we cut this piece of felt into smaller steps just like the 1st step (POINT TO 1st), how many pieces like the 1st step could we make?...
IF NECESSARY HELP CHILD LAY EXTRA PIECES OF FELT ON STEP 6.		Let's check. Use the smaller extra pieces (POINT) to see how many it will take to cover the 6th step.
		OK, how many smaller pieces did it take to cover the 6th step?... Count them... There are 6 aren't there?
	6R.	Then how many steps like the 1st step could we make if we cut up the 6th step?

((

IF CHILD FAILS:	6a.	How many pieces like the 1st step does it take to cover the 6th step (POINT)?... Count them with me again: 1, 2, ... 6. See, it takes 6 pieces to cover the 6th step. That means we can cut the 6th step into 6 pieces like the 1st step.

))

REMOVE FELT PIECES FROM STEPS 3 AND 6. PRESENT LARGER EXTRA PIECES OF FELT, AND SHOW THEY ARE THE SAME SIZE AS STEP 3.		Here are some pieces like the 3rd step. See, they are the same as Step 3 (DEMONSTRATE).
	7.	Now, if we cut the 6th step (POINT) into pieces just like the 3rd step (POINT) how many pieces could we make?

IF NECESSARY HELP CHILD PLACE STRIPS ON STEP 6.

Let's put these larger pieces like the 3rd step on top of the 6th step to see how many it takes to cover it.

Now count with me to see how many pieces it takes to cover the 6th step. 1, 2 (POINT). It takes 2, doesn't it?

7R. Then, how many steps like the 3rd step can we make if we cut the 6th step?

((

IF CHILD FAILS:

7a. Let's count again to see how many pieces like the 3rd step it takes to cover the 6th step (COUNT): 1, 2. See, it takes 2 doesn't it?... That means we can cut the 6th step into 2 pieces like the 3rd step.

))

8. Now, how many pieces like the 1st step (POINT), did we say we could make out of the 3rd step (POINT)?

HAVE CHILD PLACE SMALLEST EXTRA PIECES OVER 3rd STEP.

Let's check.

Put these smaller extra pieces (POINT) on the 3rd step and see how many it will take to cover it...

OK, let's count them: (POINT AND COUNT) 1, 2, 3. It took 3 pieces. That means we can cut the 3rd step (POINT) into 3 pieces like the 1st step (POINT).

(POINT TO LARGER EXTRA PIECES ON 6th STEP). These pieces are the same as the 3rd step (POINT). It takes 3 of the smaller pieces to cover the 3rd step (POINT).

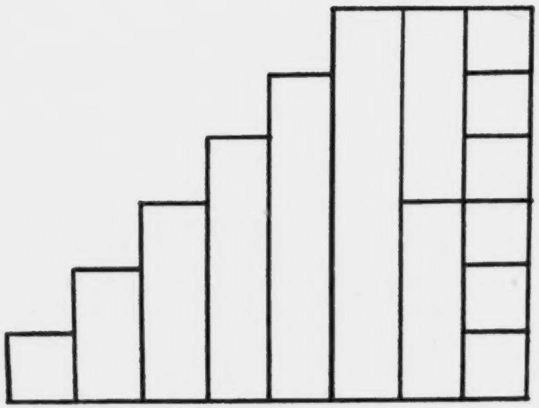
	9.	How many of the smaller pieces does it take to cover this piece (POINT TO BOTTOM PART OF THE 6th STEP)?
IF NECESSARY HELP CHILD LAY SMALLER PIECES BESIDE BOTTOM PART OF 6th STEP.		Let's put the smaller extra pieces beside the bottom piece of the 6th step and see how many it will take to be the same size... See, it takes 3, doesn't it?
	10.	How many pieces like the 3rd step (POINT) did we say it took to make the 6th step (POINT)?

((

IF CHILD FAILS:	10a.	(POINT TO 2 STRIPS COVERING 6th STEP.) These are the same size as the 3rd step. Well, then, how many pieces like the 3rd step does it take to cover the 6th step?... Count them (POINT). 1, 2. Very good.

))

MOVE 3 SMALLER PIECES SIDEWAYS, KEEPING THEM AGAINST THE GROUND, AND TAKE THE TWO #3 PIECES OFF AND PUT THESE NEXT TO STEP 6. (SEE FIGURE ON FOLLOWING PAGE).		OK, (POINT TO 2 LARGER EXTRA PIECES BY #6) it takes 2 of the 3rd step to make the 6th step (RUN FINGER OVER ALL OF #6) and it takes 3 (COUNT AS YOU REMOVE EACH SMALLER PIECE FROM STEP 3) like the 1st step to make up the 3rd step (POINT).
	11.	How many of the 1st step (POINT) do we need to make up the 6th step (POINT)?
MAKE SURE CHILD ADDS 3 MORE SMALLER PIECES ABOVE 3 ALREADY THERE.		Let's check. Use the smaller extra pieces (POINT TO PILE) to see how many pieces like the 1st step it will take to make the 6th step.



(POINT TO 3 BY BOTTOM LARGER EXTRA PIECES.) Here are 3 pieces but we'll need more. (HELP CHILD PUT 3 MORE IN PLACE.) How many did it take altogether to make the 6th step?... Let's count them (POINT) 1, 2, 3, ... 6. Very good, so it takes 6 of the 1st step to make the 6th step.

(POINT TO 2 LARGER EXTRA PIECES.) It takes 2 pieces like the 3rd step (POINT) to make the 6th step (POINT).

(POINT TO BOTTOM SMALLER EXTRA PIECES.) It takes 3 of the 1st step to make the 3rd step (POINT TO BOTTOM LARGER PIECES).

12. Then, how much is 3 two times?

((

IF CHILD FAILS TO SAY "SIX": 12a. Let's count 3 two times. (POINT TO 1 OF THE LARGER EXTRA PIECES.) Here is one 3. We call it a 3 because it equals the 3 smaller pieces beside it (POINT). (POINT TO OTHER LARGER PIECE.) Here is the second 3. We call it a 3 because it also equals the 3 smaller pieces beside it (POINT). To find out how much 3 is two times, we must count the smaller pieces beside each of the larger pieces. Count all of the smaller pieces: 1, 2, ... 6.

OK, so how much is 3 two times?

(IF CHILD FAILS, REPEAT 12a.)

))

Very good. Two times 3 equals 6.

REMOVE ALL EXTRA PIECES, PRESENT FELT PIECES FOR STEPS 7-10.

13. Here are some more steps. Let's make the stairway bigger. Remember the steps go from smallest to tallest.

((

IF CHILD FAILS:

13a. If I want to walk up the stairway will I go up with each step, or will I take a step down some where?... Where?... Fix the stairway so that I will always be going up...

))

14. How many steps are there?... Count them... 1, 2, 3, ... 10. Very good, there are 10 steps.

REPEAT QUESTION POINTING TO STEP #3, 6, 5, 8 AND 10.

15. (POINT TO 1st STEP.) How many pieces like this step can we make out of this step? (POINT TO EACH STEP--3, 6, 5, 8, 10.)

((

IF CHILD FAILS, CHECK FOR MISTAKES BY USING SMALLER EXTRA PIECES. REMEMBER TO REMOVE PIECES BEFORE GOING ON TO NEXT STEP.

15a. Let's put on the smaller extra pieces and see... count the pieces. One..., yes, we can make ____ pieces like the 1st step.

))

Very good!

DISARRANGE THE 10 STEPS.

Now I'm going to mix up the stair steps and see if you can tell which is which, OK?

REPEAT QUESTION POINTING TO STEPS 3, 7, 6, 8, AND 10.	16.	Which step is this (POINT TO 3rd)? (REPEAT QUESTION FOR 7th, 6th, 8th, AND 10th.)

((

IF CHILD FAILS:	16a.	Count the steps with me from smallest to tallest as I point to them. (E POINTS TO STEPS IN CORRECT ORDER, COUNTING OUT LOUD.) Now you count them from smallest to tallest by yourself.

NOTE: REPEAT PHASE 16a UNTIL CHILD CAN COUNT STEPS IN CORRECT ORDER.

Then this one is #___.

))

Training Log: Cardination

Tape: Number______ Side______ Meter Number______ Date:________________

Subject No.______ Group________ School______________ E__________ O__________

Starting Time______________ Finishing Time______________ Total Time______________

Part I

1. Block stairway P F
   Comment:

   1a. Corrected:________

2. How many steps? #____ P F

3. How many blocks?

#1	P	F
#2	P	F
#3	P	F
#4	P	F
#5	P	F

4. 3rd over 2nd step? P F

4a. Check:__________

5. How many more? P F

6. 3rd step to 5th #___ P F

6a. Check:__________

Part II

1. Make Stairway: P F
Comment:

2. How many in 2 P F

2R. P F

3. How many in 3 P F

3R. P F

4. Which step is (6th) P F

5. How many to (6th) P F

6. How many in (6th) P F

6R. P F

7. How many 3rd in #6 P F

7R. P F

8. Ones in #3 P F

9. Ones in 3rd piece P F

10. 3rd into 6th P F

11. Ones in #6 P F

12. Three two times P F

13. Extend Stairway P F

14. How many steps P F

15. Ones in #3 P F
#6 P F
#5 P F
#8 P F
#10 P F

16. Which step #3 P F
#7 P F
#6 P F
#8 P F
#10 P F

Appendix Q

Training: Additive Composition of Classes

Part I

Materials needed: 8 round yellow wooden beads, 8 round green wooden beads, 5 square blue wooden beads, wire, checking instrument, basket, paper clip

Procedures:	Phase	Instructions and Questions
PRESENT 2 ROUND YELLOW BEADS, 8 ROUND GREEN BEADS AND 5 SQUARE BLUE BEADS IN BASKET.		Here are some yellow, green and blue beads. Some are round and some are square. OK?
	1.	Are there more green beads or more round beads?
PRESENT CHECKING INSTRUMENT. HAVE CHILD PUT ALL THE GREEN BEADS IN A ROW. WITHOUT REMOVING THE GREEN BEADS HAVE CHILD PUT 2 YELLOW BEADS AT THE END.		Let's check and see if you're right. Put the green beads in a row. (HELP IF CHILD HAS TROUBLE.) See, they come out to here (POINT)... Now let's put all the round beads in a row.

((

IF CHILD FAILS:	1a.	Are the green beads round?... Of course; so we must keep them here. Are there any other round beads?

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IF CHILD FAILS:	1b.	Let's look at the yellow beads...are they round?... Of course they are.

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OK, then we must put them in a row too.

))

2. So, the round beads come out to here (DEMONSTRATE) and the green beads come out to here (POINT)... Do the green beads or the round beads come out farther?

((

IF CHILD FAILS:

2a. (INDICATE STARTING POINT OF GREEN BEADS.) The green beads start here and come out to here (POINT). The green and yellow beads are round. The round beads also start here (POINT) and come out to the end of the yellow ones.

Then are there more green beads, or more round ones?

(IF CHILD FAILS AGAIN, REPEAT 2a.)

))

Yes, there are more round beads. Very good!

TAKE BEADS OUT OF CHECKING INSTRUMENT AND PLACE ALL BEADS (BLUE, YELLOW, GREEN) IN BASKET IN FRONT OF CHILD.

OK, suppose there's a girl who wants to make a necklace with these beads, but she wants to use just the round ones.

3. What colors will her necklace be?

((

IF CHILD FAILS:

3a. (POINT TO YELLOW AND GREEN BEADS.) Aren't all of these beads round?...

Then what colors will her necklace of round beads be?

(REPEAT 3a UNTIL CORRECT.)

))

Of course! A necklace of round beads will be both green and yellow.

4. Which would be longer, the necklace of round beads or the one of green beads?...

TAKE OUT WIRE.

Let's check to see which would be longer. We'll make a necklace with this wire. Put the green beads on the wire. ... OK, the necklace of green beads is this long...

PLACE PAPER CLIP ON STRING AT END OF GREEN BEADS.

We'll mark it with this paper clip... Now let's put all the round beads on the wire...

((

IF CHILD FAILS:

4a. Are the green beads round?... Of course, so we must keep them here. Are there any other round beads?

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IF CHILD FAILS:

4b. Let's look at the yellow beads. Are they round?... Of course they are.

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OK, then to make the necklace of round beads we have to add the yellow beads on the wire. (HAVE CHILD DO SO.)

))

Now, the necklace of round beads is this long (DEMONSTRATE)... And the necklace of green beads is this long (POINT).

5. Which is longer, the necklace of green beads or the necklace of round beads?

((

IF CHILD FAILS:

5a. (INDICATE STARTING POINT OF GREEN BEADS.) The green beads start here and come out to here (POINT). The green and yellow beads are round. The round beads also start here (POINT) and come out to the end of the yellow ones (POINT).

Then which is longer, the necklace of green beads or the necklace of round ones?

(IF CHILD FAILS AGAIN, REPEAT 5a.)

))

Yes, the necklace of green beads is longer. Very good!

PRESENT 2 ROUND GREEN BEADS, 8 ROUND YELLOW BEADS, AND 5 SQUARE BLUE BEADS IN BASKET.

Here are some yellow, green, and blue beads. Some are round and some are square.

6. Are there more yellow beads or more round beads?

PRESENT CHECKING INSTRUMENT, HAVE CHILD PUT ALL THE YELLOW BEADS IN A ROW. WITHOUT REMOVING THE YELLOW BEADS HAVE CHILD PUT 2 GREEN BEADS AT THE END.

Let's check and see if you're right. Put the yellow beads in a row... (HELP IF CHILD HAS TROUBLE.) See, they come out to here (POINT)... Now let's put all the round beads in a row.

((

IF CHILD FAILS:

6a. Are the yellow beads round?... Of course; so we must keep them here. Are there any other round beads?

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IF CHILD FAILS: 6b. Let's look at the green beads... Are they round? ... Of course they are.

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OK, then we must put them in a row too.

))

7. So, the round beads come out to here (DEMONSTRATE). And the yellow beads come out to here (POINT)... Do the yellow beads or the round beads come out farther?

((

IF CHILD FAILS: 7a. (INDICATE STARTING POINT OF YELLOW BEADS.) The yellow beads start here and come out to here (POINT). The yellow and green beads are round. The round beads also start here (POINT) and come out to the end of the green beads.

Then are there more yellow beads, or more round ones?

(IF CHILD FAILS AGAIN, REPEAT 7a.)

))

Yes, there are more round ones. Very good!

TAKE BEADS OUT OF CHECKING INSTRUMENT AND PLACE ALL BEADS (BLUE, YELLOW, GREEN) IN BASKET IN FRONT OF CHILD.

OK, suppose there's a girl who wants to make a necklace with these beads, but she wants to use just the round ones.

8. What colors will her necklace be?

((

IF CHILD FAILS: 8a. (POINT TO YELLOW AND GREEN BEADS.) Aren't all of these beads round?

Then what colors will her necklace of round beads be?

(REPEAT 8a UNTIL CORRECT.)

))

Of course! A necklace of round beads will be both yellow and green.

9. Which would be longer, the necklace of round beads or the one of yellow beads?

TAKE OUT WIRE. Let's check to see which would be longer. We'll make a necklace with this wire. Put the yellow beads on the wire... OK, the necklace of yellow beads is this long.

PLACE PAPER CLIP ON STRING AT END OF YELLOW BEADS. We'll mark it with this paper clip... Now let's put all the round beads on the string.

((

IF CHILD FAILS: 9a. Are the yellow beads round? Of course, so we must keep them here. Are there any other round beads?

xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

IF CHILD FAILS: 9b. Let's look at the green beads. Are they round?... Of course they are.

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OK, then to make the necklace of round beads we have to add the green beads on the wire. (HAVE CHILD DO SO.)

))

Now, the necklace of round beads is this long (DEMONSTRATE) and the necklace of yellow beads is this long (INDICATE LENGTH OF NECKLACE).

10. Which is longer, the necklace of yellow beads or the necklace of round beads?

((

IF CHILD FAILS:

10a. (INDICATE STARTING POINT OF YELLOW BEADS.) The yellow beads start here and come out to here (POINT). The yellow and green beads are round. The round beads also start here (POINT) and come out to the end of the green ones.

Then which is longer, the necklace of yellow beads or the necklace of round ones?

(IF CHILD FAILS AGAIN, REPEAT 10a.)

))

TAKE BEADS FROM WIRE AND PLACE 2 GREEN, 8 YELLOW, 5 BLUE BEADS IN BASKET IN FRONT OF CHILD.

Now let's look at the round beads and the wooden beads.

11. Are there more round beads or more wooden beads?

PRESENT CHECKING INSTRUMENT.

Let's check to see if you are right. First put all the round beads in a row.

((

IF CHILD FAILS:

11a. (POINT.) Aren't these beads round too? Then we'll have to put these in the row too.

))

The round beads come out this far (POINT). Now let's make a row of all the wooden beads. Are the round beads wooden?... Yes, so we have to keep them in the row. Are there any other wooden beads?

((

IF CHILD FAILS: 11b. Look at the blue square beads. Aren't they wooden too?... Of course they are.

))

So we must put the blue wooden beads in the row too. Now, see, the round beads start here (POINT) and come out to here (POINT). Since the round beads are wooden the wooden beads start here (POINT) and come all the way to here (POINT).

12. Are there more wooden beads, or more round beads?

((

IF CHILD FAILS: 12a. (INDICATE STARTING POINT OF ROUND BEADS.) The round beads start here and come to here (POINT). Since the round and square beads are wooden, the wooden beads also start here (POINT) and come to the end of the square beads.

Then are there more round beads or more wooden ones?

(IF CHILD FAILS, REPEAT 12a.)

))

Yes, there are more wooden beads... Very good.

REMOVE BEADS FROM CHECKING INSTRUMENT AND PLACE BEADS IN BASKET.

OK, suppose a girl wants to make a necklace out of all the wooden beads.

13. What colors will her necklace be?

((

IF CHILD FAILS:

13a. (POINT TO EXCLUDED BEADS.) Aren't these beads made of wood too?... So then what colors will her necklace of wooden beads be?

(REPEAT 13a UNTIL CORRECT.)

))

Of course, the necklace of wooden beads will be green, yellow, and blue.

14. Which necklace would be longer, the necklace made of round beads or the necklace made of wooden beads?

TAKE OUT WIRE FOR CHILD TO STRING BEADS.

Let's check to make sure. First make the necklace of round beads.

((

IF CHILD FAILS:

14a. (POINT TO EXCLUDED BEADS.) Aren't these beads round too?... Of course, then let's put them on the wire.

))

PLACE PAPER CLIP ON WIRE AT END OF ROUND BEADS.

OK, the round beads make a necklace this long. We'll mark it with this paper clip. Now let's make the necklace of wooden beads... Are the round beads wooden?... Yes, of course. Are there any other beads that are wooden?

((

IF CHILD FAILS: 14b. Are the square beads wooden?... Yes, they are also made of wood.

)))

Then we must put the square beads on the necklace too.

Let's first look at the necklace of round beads. It's only this long (POINT) but the necklace of wooden beads is this long (INDICATE LENGTH OF NECKLACE).

15. Which necklace is longer, the necklace of wooden beads or the necklace of round beads?

((

IF CHILD FAILS: 15a. (INDICATE STARTING POINT OF ROUND BEADS.) The round beads start here and come to here (POINT). Since the round and square beads are also wooden, the wooden beads also start here (POINT) and come to the end of the square beads.

(IF CHILD FAILS, REPEAT 15a.)

)))

Part II

Materials needed: 8 orange wooden rhythm sticks, 8 blue wooden rhythm sticks, 4 blue wooden blocks

Phase

PRESENT 2 BLUE RHYTHM STICKS AND 8 ORANGE RHYTHM STICKS.

OK. Here are some orange and blue wooden sticks.

1. Are there more orange sticks or more wooden sticks?

Let's check to see if you're right. First, let's put all the orange sticks in a row here on the table... OK, the orange sticks make a row this big (POINT). Now let's make a row of all the wooden sticks.

((

IF CHILD FAILS:

1a. Are the orange sticks wooden?... Of course. Then we must keep them in the row. Are there any other wooden sticks?

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IF CHILD FAILS:

1b. Are these blue sticks wooden?... Yes, of course they are!

oooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooo

Then let's put them into the row with the orange sticks.

))

2. Now the wooden sticks make a row this big (POINT). And the orange sticks make a row this big (POINT). Are there more orange sticks or more wooden sticks?

((

IF CHILD FAILS:

2a. (INDICATE STARTING POINT OF ORANGE STICKS.) The orange sticks start here and come to here (POINT).

The orange and blue sticks are wooden. The wooden sticks also start here (POINT) and come to here (POINT). Then are there more orange sticks or more wooden sticks?

(IF CHILD FAILS REPEAT PHASE 2a.)

)))

Very good! There are more wooden sticks.

REMOVE 6 OF THE ORANGE STICKS AND ADD 6 MORE BLUE STICKS.

Now we're going to change some of our sticks. We'll put in more blue sticks. See?

3. Now are there more blue sticks or more wooden sticks?

Let's check to see if you're right. First let's put all the blue sticks in a row here on the table... The blue sticks make a row this big (POINT)... Now let's make a row of all the wooden sticks.

(((

IF CHILD FAILS:

3a. Are the blue sticks wooden? Of course. Then we must keep them in the row. Are there any other wooden sticks?

xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

IF CHILD FAILS:

3b. Are these orange sticks wooden?... Yes, of course they are!

ooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooo

Then they must go into the row with the blue sticks.

)))

4. Now the blue sticks make a row this big (POINT). And the wooden sticks make a row this big (POINT). Are there more blue sticks or more wooden sticks?

((

IF CHILD FAILS:

4a. (INDICATE STARTING POINT OF BLUE STICKS.) The blue sticks start here and come to here (POINT). The blue and orange sticks are wooden. The wooden sticks also start here (POINT) and come to here (POINT). Then are there more blue sticks or more wooden sticks?

(IF CHILD FAILS REPEAT PHASE 4a.)

))

Yes, very good. There are more wooden sticks.

PRESENT 4 WOODEN BLOCKS, 8 BLUE AND 2 ORANGE STICKS.

Here are some wooden blocks to go with the sticks.

5. Now let's look at all the things together. Do we have more wooden sticks or more wooden things?

Let's check and see. First put all the sticks together in a row here on the table... Now let's put all the wooden things together.

((

IF CHILD FAILS:

5a. Are all the sticks wooden?... Yes, of course they are. Are there any other wooden things?...

xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

5b. Are the blocks wooden?... Yes, of course they are.

oooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooo

Then they must go with the sticks to make a group of all the wooden things.

))

6. Now can you tell me, are there more wooden *sticks* or more wooden *things*?

((

IF CHILD FAILS:

6a. (INDICATE STARTING POINT OF WOODEN STICKS.) The wooden sticks start here and come to here (POINT). The sticks and blocks are wooden (POINT). The wooden things also start here (POINT) and come to here (POINT). Then are there more wooden sticks or more wooden things?

IF CHILD FAILS, REPEAT PHASE 6a.)

))

REMOVE STICKS AND BLOCKS FROM GROUPING AND DISARRANGE.

Now let's look at all the *blue* things and all the *wooden* things.

7. Now I want you to tell me, do we have more *blue* things or more *wooden* things?

Let's check and see if you are right. First let's make a group of all the blue things... Very good!

MOVE ORANGE STICKS OVER SO THAT ALL THINGS ARE TOGETHER.

Now let's put all the wooden things together...

((

IF CHILD FAILS:

7a. Are all the sticks wooden?... Yes, of course they are. Are there any other wooden things?

xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

IF CHILD FAILS: 7b. Are the blocks wooden?... Yes, of course they are.

ooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooo

Then they must go with the sticks to make a group of all the wooden things.

)))

8. Now are there more blue things or wooden things?

(((

IF CHILD FAILS: 8a. Show me the blue things...they are all wooden...
Show me the orange things...they are wooden too.
All of the things are wooden and only some are blue.
Are there more blue things or more wooden things?

)))

Very good, there are more wooden things.

Training Log: Additive Composition of Classes

Tape: Number_______ Side_______ Meter Number_______ Date:___________________

Subject No.______ Group________ School_________________ E__________ O__________

Starting Time________________ Finishing Time________________ Total Time________________

Part I

1. Green or round? P F
2. Green or round? P F
3. Necklace color? P F
4. Necklace length? P F
5. Necklace length? P F
6. Yellow or round? P F
7. Yellow or round? P F
8. Necklace color? P F
9. Necklace length? P F
10. Necklace length? P F
11. Round or wooden? P F
12. Wooden or round? P F
13. Necklace color? P F
14. Necklace length? P F
15. Necklace length? P F

Part II

1. Orange or wooden P F
2. Orange or wooden? P F
3. Blue or wooden? P F
4. Blue sticks or wooden sticks? P F
5. Sticks or wooden things? P F
6. Sticks or wooden things? P F
7. Blue things or wooden things? P F
8. Blue things or wooden things? P F

Appendix R

Treatment: Control Language Group

Task I

Materials needed: Modelling clay, 3" sticks, little plastic beads

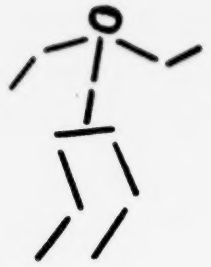
Procedures:		Instructions and Questions
PRESENT CLAY.	1.	Here is some clay for you and some for me.
ESTABLISH EQUIVALENCE.	2.	Do we both have the same amount of clay or does one of us have more?... (IF SO, "Who has more?...") Why?... How can you tell?...
	3.	IF MORE: Make them the same so that we have the same amount of clay.
MAKE A SNAKE.	4.	Let's make a snake with our clay so that they are the same.
	5.	Do we both have the same amount of clay or does one of us have more?... (IF SO, "Who has more?...") Why?... How come?... How can you tell?...
PRESENT STICKS. (16 EACH)	6.	Here are some sticks for you and some for me.
	7.	Do we both have the same number of sticks or does one of us have more?... (IF SO, "Who has more?...") Why?... How come?... How can you tell?...
PUT SIX PAIRS OF STICKS IN THE SNAKE'S SIDES.	8.	Let us pretend this is a bug with many legs.
	9.	Put the same number of legs on your bug as I have in mine.

	10. Now, do you have the same number of sticks in your clay as I have in mine or does one of us have more? (IF SO, "Who has more?...") Why?... How come?... How can you tell?...
PRESENT BEADS. (16 EACH)	11. Here are some beads for you and some for me.
	12. Do we both have the same number of beads or does one of us have more?... (IF SO, "Who has more?...") Why?... How come?... How can you tell?...
PUT 8 BEADS IN A ROW ON THE SNAKE'S BACK.	13. Let us pretend our bugs have many humps.
	14. Put the same number of beads (humps) on your bug.
	15. Now, do you have the same number of beads as I have or does one of us have more?... (IF SO, "Who has more?...") Why?... How come?... How can you tell?
USE THE SAME TYPE OF CYCLES WITH OTHER ANIMALS OR INANIMATE OBJECT UNTIL TIME IS UP.	16. Now, let's make something else.

Task II

Materials needed: same

Procedures:	Instructions and Questions
PRESENT 11 STICKS AND 1 BEAD. MAKE A STICK MAN AS SHOWN ON FOLLOWING PAGE.	1. Here are some sticks and a bead.
	2. Take the same number of sticks as I have and make a man just as I did.



3. Do we both have the same number of sticks or does one of us have more?... (IF SO, "Who has more?...") Why?... How come?... How can you tell?...
4. IF MORE: Make them the same so that we have the same number of sticks.
5. Here is some clay for you and some for me.
6. Do we both have the same amount of clay or does one of us have more?... (IF SO, "Who has more?...") Why?... How come?... How can you tell?...
7. IF MORE: Make them the same so that we have the same amount of clay.
8. Let's make a man with the clay, so that they are the same.
9. Do we both have the same amount of clay or does one of us have more?... (IF SO, "Who has more?...") Why?... How come?... How can you tell?...

Task III

Materials needed: same

Procedures:

PRESENT CLAY.

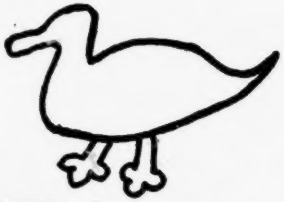
Instructions and Questions

1. Here is some clay for you and some for me.
2. Do we both have the same amount of clay or does one of us have more?... (IF SO, "Who has more?...") Why?... How come?... How can you tell?...

   (IF MORE: Make them the same.)

MAKE A DUCK.

3. Let's make a duck so that they are the same.

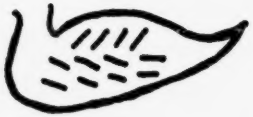


4. Do we both have the same amount of clay or does one of us have more?... (IF SO, "Who has more?...") Why?... How come?... How can you tell?...

PRESENT STICKS.
(12 EACH)

5. Here are some sticks for you and some for me.

6. Do we both have the same number of sticks or does one of us have more?... (IF SO, "Who has more?...") Why?... How come?... How can you tell?...



7. Let's put the sticks on the duck's back so that they look like feathers, like this...

8. Now, do you have the same number of sticks on your duck as I have on mine or does one of us have more?... (IF SO, "Who has more?...") Why?... How come?... How can you tell?...

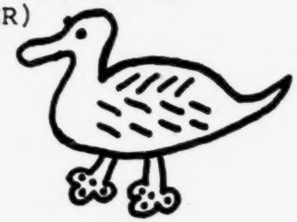
PRESENT BEADS.
(10 EACH)

9. Here are some beads for you and some for me.

10. Do we both have the same number of beads or does one of us have more?... (IF SO, "Who has more?...") Why?... How come?... How can you tell?...

PUT 4 BEADS ON EACH WEBBED FOOT AND 2 BEADS ON EITHER SIDE OF THE DUCK'S HEAD (10 ALTOGETHER)

11. Put the same number of beads on the duck's feet and head as I have in mine.



12. Now do we both have the same number of beads or does one of us have more?... (IF SO, "Who has more?...") Why?... How come?... How can you tell?...

Appendix S

Group Training: Discontinuous Quantity Conservation

Part I

Materials needed: 6 cans, 34 sticks of 2 colors

CYCLE I

Procedures:	Phase	Instructions and Questions
TEACHER AND ONE OF THE CHILDREN HAVE IDENTICAL CANS AND STICKS.		Here are two cans, they are just as big, see... Here is one for you and one for me. And here are some sticks for us. Let's fill the cans with sticks. When I put one in mine you put one in yours, okay?... Like this... (DEMONSTRATE AND CONTINUE UNTIL CANS ARE FILLED...) Very good!
ESTABLISH EQUIVALENCE.	1.	Now do we both have the same number of sticks or does one of us have more?... How can you tell?... What do the rest of you think?...
PUT RUBBER BAND AROUND BOTH SETS OF STICKS.		I'll put a rubber band around mine so that I won't lose any... Let's put a rubber band around yours.
PRESENT ANOTHER CAN (OR OTHER CANS).	2.	Here is another can (are other cans). If we put all of your sticks in this (these) can(s), will you still have the same number of sticks as I have here or will one of us have more?... (Who will have more?...) How can you tell?... What do the rest of you think?

REMOVE RUBBER BAND AND PUT S'S STICKS INTO OTHER CAN.	3.	Do we still have the same number of sticks or does one of us have more?... How can you tell?... What do the rest of you think?...
POINT TO CAN IN WHICH CHILD'S STICKS ORIGINALLY WERE.	4.	If we put them back in this can, will they fill it like mine?... Will we have the same number of sticks or will one of us have more?... How can you tell?... What do the rest of you think?...
PLACE RUBBER BAND AROUND CHILD'S STICKS.		You hold the sticks and I'll put a rubber band around them so you won't lose any... Now put them back in the can so we can check to see if you are right.
WHEN CHILD HAS PUT ALL STICKS IN SMALL CAN.	5.	Now do we have the same number of sticks or does one of us have more?... How can you tell?... What do the rest of you think?...

AFTER PHASE 5 IF CHILD PASSED PHASE 3, GO BACK TO PHASE 2 WITH ANOTHER CAN AND NEW CHILD.

IF CHILD FAILED PHASE 3, GO TO CYCLE II WITH SAME CHILD AND SAME CAN.

NOTE: AFTER THE FOURTH CAN, DIVIDE CHILD'S STICKS INTO TWO OF THE FOUR CANS AND REPEAT PHASES 2 THROUGH 5. THEN DIVIDE CHILD'S STICKS INTO ALL FOUR CANS AND REPEAT PHASES 2 THROUGH 5.

CYCLE II

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IF CHILD FAILS PHASE 3

USE SAME CAN ON WHICH CHILD JUST FAILED.	6.	If we put your sticks in this (these) can(s), will you (I) have more?... Why?... How can you tell?... What do the rest of you think?...

REMOVE BAND AND PUT CHILD'S STICKS INTO THE FAILURE CAN.		Let's take off the rubber band and put your sticks in this can again.

	7.	Do we still have the same number of sticks or does one of us have more?... (Who has more?...) Why?... How can you tell?... What do the rest of you think?
IF CHILD ANSWERS, "WE HAVE THE SAME NUMBER," FOR PHASE 7, RETURN TO CYCLE I, PHASE 4.		

))

IF CHILD SAID HE HAS MORE, GO TO CYCLE IIA.

IF CHILD SAID TEACHER HAS MORE, GO TO CYCLE IIB.

CYCLE IIA

((

NOTE: CHILD SAID HE HAS MORE STICKS.

ASK CHILD:	1a.	Did we take any sticks out of my can?... Did we put any more sticks in yours?...

ALLOW TIME FOR CHILD TO ADJUST STICKS UNTIL HE THINKS HE HAS SAME NUMBER.	2a.	Make them the same number as mine. Take out the extra ones. Count them as you take them out... Now do we have the same number of sticks or does one of us have more?... What do the rest of you think?...

HAND CHILD THE SMALL CAN AGAIN (SAME SIZE AS TEACHER'S).	3a.	If we put your sticks back in your little can, will your sticks fill it like mine do?... What do the rest of you think?...

PLACE RUBBER BAND AROUND CHILD'S STICKS AND PUT THEM BACK IN HIS SMALL CAN.	4a.	Let's put a rubber band around them so you won't lose any and put them back into your little can to check. Do they fill your can like mine?... Do we have the same number of sticks or does one of us have more?... What happened?...
HAVE CHILD PUT BACK THE STICKS HE TOOK OUT.		Count the ones you took out. Now see how many sticks it will take to fill your can... See you had to use all the sticks you took out to fill your can like mine.
	5a.	With the sticks you took away back in your can, do we both have the same number of sticks or does one of us have more?... How can you tell?... What do the rest of you think?...
		That's right, if we put back the sticks you took away, we have the same number of sticks. When your can is full like mine, we know we have the same number of sticks.

))

GO BACK TO PHASE 2, CYCLE I, WITH A NEW CAN AND ANOTHER CHILD.

CYCLE IIB

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NOTE: CHILD SAID TEACHER HAS MORE STICKS.

ASK CHILD:	1b.	Did we take any out of your can?... Did we put any more in mine?...

GIVE CHILD EXTRA STICKS AND ALLOW TIME FOR CHILD TO ADJUST STICKS UNTIL HE THINKS HE HAS THE SAME NUMBER. MAKE SURE CHILD KEEPS TRACK OF ADDED ONES.	2b.	Make them the same number as mine. Here are some extra sticks. Let's count them as you put them in... Now do we have the same number or does one of us have more?... What do the rest of you think?...
HAND CHILD THE SMALL CAN (SAME SIZE AS TEACHER'S).	3b.	If we put your sticks back in your little can, will your sticks fill it like mine do?... What do the rest of you think?...
PLACE RUBBER BAND AROUND CHILD'S STICKS AND PUT THEM BACK IN HIS LITTLE CAN.	4b.	Let's put a rubber band around them so you won't lose any and put them back into your little can to check. Do they fill your can like mine do?... Do we have the same number of sticks or does one of us have more?... What happened?... Why won't they all go in?... How many sticks won't go in?... That is the same number of extra ones you put in!
	5b.	If we take away all the extra ones you put in, will we have the same number of sticks or will one of us have more?... How can you tell?... What do the rest of you think?... That's right, if we take away all the extra ones you put in, we will have the same number of sticks. When your can is full like mine, we know we have the same number of sticks.

))

GO BACK TO PHASE 2, CYCLE I WITH A NEW CAN AND ANOTHER CHILD.

Part II

Materials needed: 6 wooden boxes, 30 erasers

CYCLE I

Procedures:	Phase	Instructions and Questions
TEACHER AND ONE OF THE CHILDREN HAVE IDENTICAL BOXES AND ERASERS.		Here are two boxes, they are just as big, see. Here is one for you and one for me. And here are some erasers for us. Let's fill the boxes with erasers. When I put one in mine you put one in yours, okay? Like this... (DEMONSTRATE). Very good!
ESTABLISH EQUIVALENCE.	1.	Now do we both have the same number of erasers or does one of us have more?... Why?... How can you tell?... What do the rest of you think?...
PRESENT ANOTHER BOX (OTHER BOXES).	2.	Here is another box (are other boxes). If we put all of your erasers in this (these) box(es), will you still have the same number of erasers as I have here or will one of us have more?... (Who will have more?...) Why?... How can you tell?... What do the rest of you think?...
DUMP CHILD'S ERASERS INTO OTHER BOX.	3.	Do we still have the same number of erasers or does one of us have more?... (Who has more?...) Why?... How can you tell?... What do the rest of you think?
POINT TO BOX IN WHICH CHILD'S ERASERS ORIGINALLY WERE.	4.	If we put them back in this box, will they fill it like mine?... Will we have the same number of erasers or will one of us have more?... Why?... How can you tell?... What do the rest of you think?

		Okay, let's see if you're right. Put them back in the box so we can check. Put them in, one at a time, just like you did before. Just like mine.
WHEN CHILD HAS PUT ALL 10 ERASERS IN SMALL BOX...	5.	Now do we have the same number or does one of us have more?... Why?... How can you tell?... What do the rest of you think?...

IF CHILD PASSES PHASE 3 GO BACK TO PHASE 2 WITH ANOTHER BOX AND NEW CHILD.

OTHERWISE GO TO CYCLE II WITH SAME CHILD AND SAME BOX.

NOTE: AFTER THE FOURTH BOX, DIVIDE CHILD'S ERASERS INTO TWO OF THE FOUR BOXES AND REPEAT PHASE 2 THROUGH 5. THEN DIVIDE CHILD'S ERASERS INTO ALL FOUR BOXES AND REPEAT PHASE 2 THROUGH 5.

CYCLE II

((

IF CHILD FAILS PHASE 3

USE SAME BOX ON WHICH CHILD JUST FAILED.	6.	If we put your erasers in this (these) box(es), will you (I) have more?... Why?... How can you tell?... What do the rest of you think?...
DUMP ERASERS BACK INTO FAILURE BOX.		Let's put them in here again.
	7.	Do we still have the same number of erasers or does one of us have more?... (Who has more?...) Why?... How can you tell?... What do the rest of you think?

IF CHILD ANSWERS "WE HAVE THE SAME NUMBER OF ERASERS" FOR PHASE 7, RETURN TO CYCLE I, PHASE 4.

)))

IF CHILD SAID HE HAS MORE, GO TO CYCLE IIA.

IF CHILD SAID TEACHER HAS MORE, GO TO CYCLE IIB.

CYCLE IIA

(((

NOTE: CHILD SAID HE HAS MORE ERASERS.

ASK CHILD:	1a.	Did we take any erasers out of my box?... Did we put any more erasers in yours?...
ALLOW TIME FOR CHILD TO ADJUST ERASERS UNTIL HE THINKS HE HAS THE SAME NUMBER.	2a.	Make them the same number as mine. Take out the extra ones. Count them as you take them out... Now do we have the same number of erasers or does one of us have more?... What do the rest of you think?...
HAND CHILD THE SMALL BOX AGAIN (SAME SIZE AS TEACHER'S).	3a.	If we put your erasers back in your little box will your erasers cover the bottom of the box like mine do?... What do the rest of you think?...
HAVE CHILD PUT ERASERS BACK ONE BY ONE.	4a.	Let's put your erasers back into your little box one at a time to check. Do they cover the bottom of your box like mine?... Do we have the same number of erasers or does one of us have more?... What happened?

HAVE CHILD PUT BACK THE ERASERS HE TOOK OUT.

Count the ones you took out. Now see how many erasers it will take to cover the bottom of your box... See, you had to use all the erasers you took out to cover the bottom of your box like mine.

5a. With the erasers you took away back in your box, do we both have the same number of erasers or does one of us have more?... How can you tell?... What do the rest of you think?...

That's right, if we put back the erasers you took away, we have the same number of erasers. When the bottom of both boxes is covered we know we have the same number of erasers.

))

GO BACK TO PHASE 2, CYCLE I WITH A NEW BOX AND ANOTHER CHILD.

CYCLE IIB

((

NOTE: CHILD SAID TEACHER HAS MORE ERASERS.

ASK CHILD:

1b. Did we take any out of your box?... Did we put any more in mine?...

GIVE CHILD EXTRA ERASERS, AND ALLOW TIME FOR CHILD TO ADJUST ERASERS UNTIL HE THINKS HE HAS SAME NUMBER. MAKE SURE CHILD KEEPS TRACK OF ADDED ONES.

2b. Make them the same number as mine. Here are some extra erasers. Let's count them as you put them in... Now do we have the same number or does one of us have more?... What do the rest of you think?

HAND CHILD THE SMALL BOX (SAME SIZE AS TEACHER'S).	3b.	If we put your erasers back in your little box, will your erasers cover the bottom of your box like mine do?... What do the rest of you think?...

HAVE CHILD PUT ERASERS BACK ONE BY ONE.	4b.	Let's put your erasers back into your little box one at a time to check. Do they cover the bottom of your box like mine?... Do we have the same number of erasers or does one of us have more? What happened?...
		Why won't they all go in?... How many erasers won't go in?... That is the same number of extra ones you put in!
	5b.	If we take away all the extra ones you put in, will we have the same number of erasers or will one of us have more?... How can you tell?... What do the rest of you think?...
		That's right, if we take away the extra ones you put in, we'll have the same number of erasers. When the bottom of both boxes is covered we know we have the same number of erasers.

))

GO BACK TO PHASE 2, CYCLE I WITH A NEW BOX AND ANOTHER CHILD.

Training Log: Discontinuous Quantity

Subject No.______ School____________________ Date:________________________

Experimenter____________________ Observer__________________

Part I (Sticks and Cans) _____

Part II (Erasers and Boxes) _____

1.	Equivalence? Reason:		P	F
2.	Prediction on Box/Can #______ Reason:		P	F
3.	Equal? Reason:		P	F
4.	Reversal.	Prediction:	P	F
	Same or more Reason:		P	F
5.	Equivalence? Reason:		P	F

IF FAIL:

6.		Prediction:	P	F
7.		Equal?	P	F
		Who has more?	E	S
1a.	(1b.)	Take any out	Yes	No
		Put any in	Yes	No
2a.	(2b.)	Take out/Put in	Yes	No
3a.	(3b.)	Prediction (Equal)	Yes	No
4a.	(4b.)	Equal Reason:	Yes	No
5a.	(5b.)	Equal Reason:	Yes	No

Appendix T

Group Training: Ordination

Materials needed: Zerbils, doors, door stand, and clips

Procedures:	Phase	Instructions and Questions
TEACHER AND CHILDREN SEATED AT TABLE.		Here are some funny looking people. We call them Zerbils. Each has only one eye. Therefore, they must walk in a straight line so they can see if there is danger ahead.
PRESENT ZERBILS #1, 4, 7, 9, 10.		Let's put these Zerbils in a line so the smallest one is 1st, then the next smallest, and so on to the tallest. Their eyes must all be pointing one way, and each one must be able to see over the one in front of him. Only when they walk in a line, from smallest to tallest, can each see over the head of the others. We will take turns putting them in line.
TEACHER - PICK SMALLEST ZERBIL, COMPARE IT WITH OTHER ZERBILS AND START THE LINE.		This is the smallest Zerbil. See? (COMPARE IT WITH EACH OF THE OTHER ZERBILS.) I'll start the line by placing him here.
STARTING WITH ANY CHILD, HAVE CHILDREN TAKE TURNS PUTTING ZERBILS IN LINE.	1.	(CHILD'S NAME), you find the next smallest Zerbil and put it in line. (REPEAT WITH NEW CHILD UNTIL ZERBILS ARE ALL IN LINE.)

((

IF ANY CHILD FAILS, POINT TO ZERBIL CHILD CHOOSES.	1a.	(POINT.) Is this one the next smallest?... What do the rest of you think?... Let's check to see who is right.
PICK UP FAILURE ZERBIL AND COMPARE WITH REMAINING ZERBILS.	1b.	Let's compare this Zerbil with the rest of the Zerbils not in line and see if it is the smallest one. Is this one in my hand smaller than this one?... (COMPARE WITH EACH UNTIL ANSWER IS "NO." EXCHANGE ZERBIL IN HAND WITH "NO" ZERBIL AND REPEAT 1b ONLY IF "NO" ZERBIL IS NOT SMALLEST.)
WHEN CHILD SAYS NO, EXCHANGE ZERBIL IN HAND WITH "NO" ZERBIL AND REPEAT 1b UNTIL SMALLEST IS FOUND.		Good! Since this is the smallest of all those not in line yet and just bigger than this one (POINT TO LAST ONE IN CORRECT LINE), we must put it in line next. (GO BACK TO PHASE 1 UNTIL ALL ZERBILS ARE IN LINE.)

))

PRESENT REMAINING ZERBILS #2, 3, 5, 6, AND 8.		These Zerbils want to walk with the others. Remember, they also need to be in line from smallest to tallest so they can see over the heads of the ones in front of them. Let's take turns putting them in the line between the others where they belong.
TEACHER RANDOMLY SELECT ONE ZERBIL AND HAVE CHILD PUT IT IN PLACE.	2.	(CHILD'S NAME), put this one in his place. (REPEAT WITH NEW ZERBIL AND NEW CHILD UNTIL ALL ZERBILS ARE IN LINE.)

((

IF ANY CHILD FAILS, POINT TO ZERBIL TALLER THAN THE ONE BEHIND IT AND ASK:	2a.	(POINT TO TALLER ZERBIL.) Is this Zerbil smaller than the one behind or in back of it?... (POINT TO SHORTER ONE BEHIND.) Then can this smaller Zerbil see over the head of this one (POINT TO TALLER ONE IN FRONT)?...
MOVE MISPLACED ZERBIL ALONGSIDE LINE OF ZERBILS SO THAT CHILD CAN VISUALLY COMPARE AND CHOOSE SPOT.		Show me where you would put this Zerbil in line between the other Zerbils so that the line of Zerbils would be from smallest to tallest. Point to the spot between the other Zerbils where this one should go... (PUT ZERBIL IN PLACE CHILD CHOSE.)
		(IF PLACE IS INCORRECT, REPEAT 2a.)
		(IF PLACE IS CORRECT, GO BACK TO PHASE 2 WITH NEW CHILD, UNTIL ALL ZERBILS ARE IN LINE.)

))

	Good! Now all Zerbils can see in front of them.
MOVE ZERBILS TO RIGHT, KEEPING THEM IN ORDER.	Now the Zerbils have gone for a walk.
	These Zerbils live in houses that we can't see, but we can see their front doors.
PRESENT DOORS.	Here are the doors to the houses the Zerbils live in. Let's put them in a line like you did the Zerbils so that each Zerbil can quickly find his home. Let's start with the smallest door first. We'll take turns putting them in line from smallest to tallest.
PRESENT DOOR STAND AS STRAIGHT EDGE.	Use this (DOOR STAND) to make sure they're in a straight line.

TEACHER: PICK SMALLEST DOOR, COMPARE IT WITH OTHER DOORS, AND START THE LINE.		This is the smallest door, see?... (COMPARE WITH EACH OF THE OTHER DOORS.) I'll start the line by placing it here.
STARTING WITH ANY CHILD, HAVE CHILDREN TAKE TURNS PUTTING DOORS IN LINE.	3.	(CHILD'S NAME), you find the next smallest door and put it in line. (REPEAT UNTIL DOORS ARE ALL IN LINE.)

((

IF ANY CHILD FAILS, POINT TO DOOR CHILD CHOSE AND SAY:	3a.	Is this one the next smallest?... What do the rest of you think?... Let's check to see who is right.
PICK UP FAILURE DOOR AND COMPARE WITH REMAINING DOORS.	3b.	Let's compare this door with the rest of the doors not in line and see if it is the smallest one. Remember we are going from smallest to tallest and we want to find the smallest remaining door not in line. Is this one in my hand smaller than this one?
WHEN CHILD SAYS NO, EXCHANGE DOOR IN HAND WITH "NO" DOOR AND REPEAT 1b UNTIL SMALLEST IS FOUND.		(COMPARE WITH EACH UNTIL ANSWER IS "NO." EXCHANGE DOOR IN HAND WITH "NO" DOOR AND REPEAT 1b ONLY IF "NO" DOOR IS NOT THE SMALLEST.) Good, since this is the smallest of all these not in line yet and just bigger than this one (POINT TO LAST ONE IN CORRECT LINE), we must put it in line next. (GO BACK TO PHASE 3 UNTIL ALL DOORS ARE IN LINE.)

))

PLACE DOORS IN THE STAND AND MOVE THEM TO THE LEFT.	I'll put the doors in this stand so that the Zerbils can find them.

LET EACH CHILD IN GROUP TAKE TURNS BRINGING A ZERBIL BACK (FROM SMALLEST TO TALLEST FACING ONE DIRECTION.)		Now the Zerbils are very tired and ready to come back from their walk. Let's take turns bringing them back, from smallest to tallest, the smallest one 1st. I'll bring the smallest one back.
	4.	(CHILD'S NAME), bring the next smallest Zerbil back from the walk.
		(REPEAT WITH NEW CHILD AND NEW ZERBIL UNTIL ALL ZERBILS ARE BACK.)
		Very good!
PRESENT THE DOORS IN REVERSE ORDER TO THE ZERBILS.		Now the Zerbils are back from their walk. They are so tired that they want to take a nap.
LET ONE CHILD AT A TIME POINT TO ONE ZERBIL AT A TIME IN THIS ORDER: #2, 4, 9, 1, 6, 8, 7, 5, 3, 10. ZERBIL NUMBER SHOULD BE SAME AS DOOR NUMBER FROM SMALLEST TO TALLEST.	5.	(CHILD'S NAME), point to the Zerbil that goes with this door...
PUT CLIP ON DOOR DISCUSSED.		(CLIP IN TURN #2, 4, 9, 1, 6, 8, 7, 5, 3, 10.)

((

IF ANY CHILD FAILS:	5a.	We can number the Zerbils from smallest to tallest. The smallest Zerbil is #1, the next smallest is #2, and so on. We can also number the doors from smallest to tallest. The smallest door is #1 and the next smallest door is #2, and so on. Now the smallest or #1 Zerbil goes in the smallest, or #1 door. Okay? Remember, the number of the Zerbil should be the same as the number of the door.

Well then, point to the Zerbil which goes into the door with the clip on it... What number is that Zerbil?...

xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

IF CHILD STILL FAILS:

5b. Which number door is the clip on?... Remember the smallest door is #1. Count them out loud with me up to the door with the clip on it. 1, 2, ... Good, this is door #___. Now count the Zerbils out loud with me from smallest to tallest until you get to the same number. 1, 2, ... Good, then this Zerbil goes into the door with the same number.

oooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooo

(AFTER CHILD SELECTS CORRECT ZERBIL GO BACK TO PHASE 5 UNTIL COMPLETE.)

))

REMOVE DOORS 7 THROUGH 10.
REMOVE ZERBILS 7 THROUGH 10.

Very good. Now these Zerbils have gone on a camping trip and have taken their doors with them.

DISARRANGE ZERBILS SO THAT THEY ARE STANDING IN RANDOM (ANY) ORDER.

While they are gone, the others will play and get all mixed up. (MIX ZERBILS UP.)

Now we want to help these Zerbils find their own doors. One way to help them is to put the Zerbils back in a line like their doors, but for now let's just point to the Zerbil, okay?

(POINT.) This Zerbil is the smallest. It will go in the smallest door (POINT).

HAVE CHILDREN TAKE TURNS POINTING OUT ZERBILS ONE AT A TIME.

6. Remember now, we can give each Zerbil a number. The smallest Zerbil will be #1.

(CHILD'S NAME), which Zerbil will be (#2?), (#3?), (#4?), (#5?), (#6?)? (USE NEW CHILD WITH EACH NUMBER.)

((

IF ANY CHILD FAILS, PUT ZERBILS BACK IN ORDER FROM SMALLEST TO TALLEST.

6a. No, that is the wrong Zerbil. I will put them in line from smallest to tallest to help you... Remember, the smallest is number 1. Okay, now can you find Zerbil #___?...

xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

IF CHILD STILL FAILS POINT TO EACH ZERBIL AND HAVE CHILD COUNT UNTIL HE REACHES THE RIGHT ZERBIL.

6b. Count with me as I point to each Zerbil. 1, 2, ... (STOP AFTER RIGHT ZERBIL.) Yes, here is Zerbil #___. See, to find the right Zerbil when they are all mixed up, you have to put them in your head like this and count up from the smallest to the Zerbil you want.

ooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooo

All right, let's go on.

NOTE: DISARRANGE ZERBILS AGAIN AND CONTINUE WITH NEW CHILD UNTIL ZERBIL #6.

))

LEAVE ZERBILS IN RANDOM ORDER.

Now let's see if you can help each Zerbil find his own door by yourself. See if you can get it right on the first try, okay?

TAKE TURNS WITH NEW CHILD AS YOU CLIP EACH DOOR DISCUSSED.

7. Point to the Zerbil that will go into this door... (CLIP IN TURN #2, 4, 1, 6, 5, 3.)

((

IF ANY CHILD FAILS:

7a. Let's find out which door the clip is on. Remember the smallest is #1. Point and count out loud...

Yes, this is door #___. Now which Zerbil will go into this door?... Count the Zerbils from smallest to tallest. Point and count out loud...

xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

IF CHILD COUNTS THEM IN WRONG ORDER, STOP AT FIRST ERROR.

7b. No! (POINT TO RIGHT ONE.) Doesn't this one come next?... See, he's just a little taller than this last one we counted and smaller than the ones we haven't counted. (TEACHER PICK UP ZERBIL AND DEMONSTRATE.) So he is #___.

REPEAT FOR EACH ERROR UNTIL CHILD REACHES RIGHT ZERBIL.

oooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooo

WHEN CHILD REACHES RIGHT ZERBIL:

All right, this is Zerbil #___. Remember, I asked which Zerbil will go into this door (POINT). This is door #___ and this is Zerbil #___ (POINT). This Zerbil then goes into this door because they both have the same number.

))

Very good!

Training Log: Ordination

Subject No.__________ School______________________ Date:____________________

Experimenter______________________ Observer______________________

Child #								Failure Corrected	
____	1.	Order Zerbils:	# 4	P	F	1a.		Yes	No
____			7	P	F			Yes	No
____			9	P	F			Yes	No
____			10	P	F			Yes	No
____	2.	Put in remainder:	#___	P	F	2a.	#___	Yes	No
____			___	P	F		___	Yes	No
____			___	P	F		___	Yes	No
____			___	P	F		___	Yes	No
____			___	P	F		___	Yes	No
____	3.	Order Doors:	# 2	P	F				
____			3	P	F				
____			4	P	F				
____			5	P	F				
____			6	P	F				
____			7	P	F				
____			8	P	F				

______		# 9	P	F			
______		10	P	F			
______	5. Matching Zerbils and Doors	# 2	P	F	5a.	P	F
______		4	P	F		P	F
______		9	P	F		P	F
______		1	P	F		P	F
______		6	P	F		P	F
______		8	P	F		P	F
______		7	P	F		P	F
______		5	P	F		P	F
______		3	P	F		P	F
______		10	P	F		P	F
______	6. Disarrangement:	# 2	P	F	6a.	P	F
______		3	P	F		P	F
______		4	P	F		P	F
______		5	P	F		P	F
______		6	P	F		P	F

_____	7. Random Order:	# 2	P	F	7a.	P	F
_____		4	P	F		P	F
_____		1	P	F		P	F
_____		6	P	F		P	F
_____		5	P	F		P	F
_____		3	P	F		P	F

Appendix U

Group Training: Cardination

Part I

Materials needed: 15 square wooden blocks for steps, plus 3 extra blocks

Procedures:	Phase	Instructions and Questions
MAKE 5 STAIR STEPS. TEACHER PUTS 1st BLOCK (STEP) OUT. HAVE ONE CHILD AT A TIME MAKE ONE STEP AT A TIME - EACH STEP 1 BLOCK HIGHER THAN THE LAST ONE.		Here are some wooden blocks. Build a stairway of 5 steps with these blocks so that the 1st step is one block high, the 2nd step is two blocks high, and so on. Let's take turns. I'll start the stairway by putting this block here as the 1st step.
	1.	(CHILD'S NAME), build the next step. (REPEAT UNTIL FINISHED.)

((

IF ANY CHILD FAILS, POINT OUT INDIVIDUAL STEPS FOR HIM.	1a.	Remember the 1st step is 1 block high, the 2nd step will be 2 blocks high, and so on. Each step is 1 block higher than the last one. Is this step 1 block higher than this step (POINT)?... Then make it 1 block higher. (REPEAT PHASE 1a UNTIL CHILD CORRECTS ERROR.)

NOTE: RETURN TO PHASE 1 WITH NEW CHILD UNTIL STAIRWAY IS FINISHED.

))

	2.	(CHILD'S NAME), how many steps are there in the stairway?... If we were to walk up the stairway, how many steps would we go up?...

((

IF CHILD FAILS, HAVE HIM COUNT. PICK UP COUNTING WHERE HE FALTERS, POINTING TO EACH STAIR STEP AS YOU SAY THE NUMBER.	2a.	Let's count the steps together. Remember, we are counting steps, not blocks. 1, 2, ... 5 (POINT TO EACH STEP).

))

		Good. There are 5 stairsteps.
LET NEW CHILD ANSWER EACH TIME FOR EACH STEP - #1, 2, 3, 4, AND 5. SUBSTITUTE 1st, 2nd, 3rd, 4th, AND 5th STEP IN ORDER.	3.	Now, (CHILD'S NAME), how many blocks are used for the 1st step?... (SUBSTITUTE 2nd/3rd/4th/or 5th IN ORDER.) (REPEAT PHASE 3 AND SUBSTITUTE RIGHT NUMBER WITH NEW CHILD).

((

IF ANY CHILD FAILS, HELP BY POINTING TO THE INDIVIDUAL BLOCKS AND COUNTING THEM. SEPARATE, IF NECESSARY.	3a.	Let's count them together. (1, 2, ...) Good, there are ___ blocks in the ___ step.

))

POINT TO BLOCKS IN STEP 2 AND 3.	4.	(CHILD'S NAME), which step has more blocks, this one (POINT TO #2) or this one (POINT TO #3)?...

((

IF CHILD FAILS: 4a. Let's look at these two steps again. (POINT TO STEP 2.) How many blocks in this one?... Count with me... 1, 2. So there are 2 blocks in this one. (POINT TO STEP 3.) Now let's count the blocks in this step... 1, 2, 3. So there are 3 blocks (POINT) in this step and 2 blocks (POINT) in the other. We know 3 is more than 2, so this step (POINT TO #3) has more blocks than this one (POINT).

))

5. How many more blocks are in the 3rd (POINT) step than are in the 2nd step (POINT)?

(POINT TO #3.) How many blocks do you need to take away from this one to make it the same as this one (POINT TO #2)?...

((

IF CHILD FAILS: 5a. If you take (CHILD'S NUMBER) blocks off from the 3rd step, will it be the same size as the 2nd step?...

Show me...

No, they are not the same, are they?...

Here, let's start over again. (PUT BLOCKS BACK.) Take away only one block from the 3rd step... Now are they the same?...

Yes, of course they are the same. So the 3rd step has only 1 block more than the 2nd step.

Okay, now put the block back to make the 3rd step again.

))

6. (CHILD'S NAME), how many blocks will we have to add to the 3rd step (POINT) to make it the same size as the 5th step (POINT)?...

((

IF CHILD FAILS, PRESENT HIM WITH THE 3 EXTRA BLOCKS.

Here are some more blocks. Let's add (CHILD'S NUMBER) blocks to the 3rd step (POINT) and see.

6a. Is it as tall as the 5th step now?... What must we do to the 3rd step (POINT) to make it the same size as the 5th step (POINT)?...

(IF STILL INCORRECT:) Okay. (ADD/TAKE AWAY CHILD'S NUMBER BLOCK(S) TO THE 3rd STEP.) Now are they the same size?... No, they're not. (REMOVE EXTRA BLOCKS.)

What can we do to make the 3rd step (POINT) the same size as the 5th step (POINT)?...

(IF STILL INCORRECT, HAVE CHILD TAKE AWAY OR ADD ACCORDING TO HIS ANSWER AND REPEAT PHASE 6a UNTIL CORRECT.)

))

Very good! It takes 2 blocks to make the 3rd step as tall as the 5th step.

(REMOVE BLOCKS.)

Part II

Materials needed: 10 strips of felt for stairway, extra pieces of felt, wooden stick for base, clothes pin

Procedures:	**Phase**	**Instructions and Questions**
PRESENT FELT FOR FIRST 6 STEPS.		Now here are some pieces of felt which we can pretend are a stairway. (PRESENT STICK.) This will be the bottom of our stairway and we will build the steps on this.
HAVE EACH CHILD PLACE ONE STEP AT A TIME FROM SMALLEST TO TALLEST.		Let's see if we can make the stairway by laying these pieces side by side in a row from smallest to tallest. We'll take turns.
		I'll start the stairway by putting in the 1st step with the smallest piece.
	1.	(CHILD'S NAME), you put in the next step.
		(REPEAT FOR EACH CHILD UNTIL STAIRWAY IS FINISHED.)

((

IF ANY CHILD FAILS, HAVE HIM COMPARE PIECE OF FELT HE CHOSE TO REMAINING PIECES UNTIL HE FINDS THE RIGHT ONE.	1a.	Remember now, we want the steps to go from smallest to tallest. (POINT TO CHILD'S PIECE.) Is this step the smallest of the steps not in the row?... (PUT HIS PIECE AGAINST EACH REMAINING PIECE.) No! Which one is the smallest?... Well then, it should be the next step.

NOTE: RETURN TO PHASE 1 WITH NEW CHILD UNTIL STAIRWAY IS FINISHED.

))

AFTER STAIRWAY IS COMPLETE:

2. Very good! Now, (CHILD'S NAME), if we were to cut the 2nd step (POINT) into pieces, how many pieces could we make like this 1st step (POINT)?...

PRESENT EXTRA PIECES AND SHOW THAT THEY ARE SAME AS STEP 1.

Here are some pieces of felt the same as the 1st step. See? (DEMONSTRATE.)

HAVE CHILD COVER THE 2nd STEP WITH EXTRA PIECES OF FELT.

Put these pieces, one at a time, over the 2nd step and see how many pieces it takes to cover the 2nd step.

Now, how many pieces like the 1st step did it take to cover the 2nd step?... It took 2, didn't it?...

2R. Then how many steps like the 1st step can we make if we cut up the 2nd step?...

((

IF CHILD FAILS:

2a. (POINT TO PIECES COVERING STEP 2). Remember, these pieces are the same size as this 1st step (POINT). See, it takes 2 of these pieces to cover the 2nd step (POINT). This means that we can cut the 2nd step into 2 pieces like the 1st step.

))

RAISE VOICE ON UNDERLINED WORDS.

Good! It takes 2 (USE 2 FINGERS TO SHOW CLEARLY) of the 1st step (POINT TO 1st) to make, or equal, the 2nd step (POINT TO 2nd).

MOVE EXTRA SQUARES FROM STEP 2, BUT LEAVE THEM WITHIN REACH OF THE CHILDREN.

	3.	Now, (CHILD'S NAME), tell me how many pieces like the 1st step (POINT) could we make if we cut up the 3rd step (POINT)?...
POINT TO EXTRA SQUARES.		Use the smaller extra pieces of felt again and see how many pieces it takes to cover the 3rd step...
		Now, how many pieces did it take to cover the 3rd step?... It took 3, didn't it?...
	3R.	Then how many steps like the 1st step (POINT) can we make if we cut up the 3rd step?... (POINT.)

((

IF CHILD FAILS:	3a.	(POINT TO PIECES COVERING STEP 3.) Remember, these pieces are the same size as the 1st step (POINT). See, it takes 3 of these pieces to cover the 3rd step. That means we can cut the 3rd step into 3 pieces like the 1st step.

))

		Very good, we can make 3 pieces like the 1st step when we cut the 3rd step.
RAISE VOICE ON UNDERLINED WORDS.		Now we know that the 2nd step can be cut into 2 pieces like the 1st step and the 3rd step can be cut into 3 pieces like the 1st step.
	4.	Okay, we have talked about the 1st step, the 2nd step, and the 3rd step.
		(CHILD'S NAME), (POINT TO 6th) which step number is this?...

((

IF CHILD FAILS:

4a. Let's count the steps together and see: 1, 2, 3, 4, 5, 6.

Good, this is the 6th step.

))

5. (CHILD'S NAME), how many steps would I have to climb to get to the stop of the stairs?...

USE 2 FINGERS IN A "WALKING MOTION" UP THE STAIRS.

Let's see if you're right. Count the steps with me as I point to them (POINT), 1, 2...6. How many did we count?... That means I would have to climb 6 steps to get to the top of the stairs, doesn't it?

6. (POINT TO STEP #6). And, (CHILD'S NAME), if we cut this piece of felt into smaller steps just like the 1st step (POINT TO 1st), how many pieces like the 1st step could we make?...

IF NECESSARY HELP CHILD LAY EXTRA PIECES OF FELT ON STEP 6.

Let's check. Use the smaller extra pieces (POINT) to see how many it will take to cover the 6th step.

Okay, how many smaller pieces did it take to cover the 6th step?... Count them... There are 6 aren't there?...

6R. Then how many steps like the 1st step could we make if we cut up the 6th step?...

((

IF CHILD FAILS:

6a. How many pieces like the 1st step does it take to cover the 6th step (POINT)?... Count them with me again: 1, 2, ... 6. See, it takes 6 pieces to cover the 6th step. That means we can cut the 6th step into 6 pieces like the 1st step.

))

REMOVE FELT PIECES FROM STEPS 3 AND 6. PRESENT LARGER EXTRA PIECES OF FELT, AND SHOW THEY ARE THE SAME SIZE AS STEP 3.		Here are some pieces like the 3rd step. See, they are the same as Step 3 (DEMONSTRATE).
	7.	Now, (CHILD'S NAME), if we cut the 6th step (POINT) into pieces just like the 3rd step (POINT), how many pieces could we make?...
IF NECESSARY HELP CHILD PLACE STRIPS ON STEP 6.		Let's put these larger pieces like the 3rd step on top of the 6th step to see how many it takes to cover it.
		Now count with me to see how many pieces it takes to cover the 6th step. 1, 2 (POINT). It takes 2, doesn't it?...
	7R.	Then, how many steps like the 3rd step can we make if we cut the 6th step?...

((

IF CHILD FAILS:	7a.	Let's count again to see how many pieces like the 3rd step it takes to cover the 6th step (COUNT:) 1, 2. See, it takes 2 doesn't it?... That means we can cut the 6th step into 2 pieces like the 3rd step.

))

	8.	Now, (CHILD'S NAME), how many pieces like the 1st step (POINT), did we say we could make out of the 3rd step (POINT)?...
HAVE CHILD PLACE SMALLEST EXTRA PIECES OVER 3rd STEP.		Let's check.
		Put these smaller extra pieces (POINT) on the 3rd step and see how many it will take to cover it...

Okay, let's count them: (POINT AND COUNT) 1, 2, 3... It took 3 pieces. That means we can cut the 3rd step (POINT) into 3 pieces like the 1st step (POINT).

(POINT TO LARGER EXTRA PIECES ON 6th STEP.) These pieces are the same as the 3rd step (POINT). It takes 3 of the smaller pieces to cover the 3rd step (POINT).

9. (CHILD'S NAME), how many of the smaller pieces does it take to cover this piece (POINT TO BOTTOM PART OF THE 6th STEP)?...

IF NECESSARY HELP CHILD LAY SMALLER PIECES BESIDE BOTTOM PART OF 6th STEP.

10. How many pieces like the 3rd step (POINT) did we say it took to make the 6th step (POINT)?...

((

IF CHILD FAILS:

10a. (POINT TO 2 STRIPS COVERING 6th STEP.) These are the same size as the 3rd step. Well, then, how many pieces like the 3rd step does it take to cover the 6th step?... Count them (POINT), 1, 2. Very good.

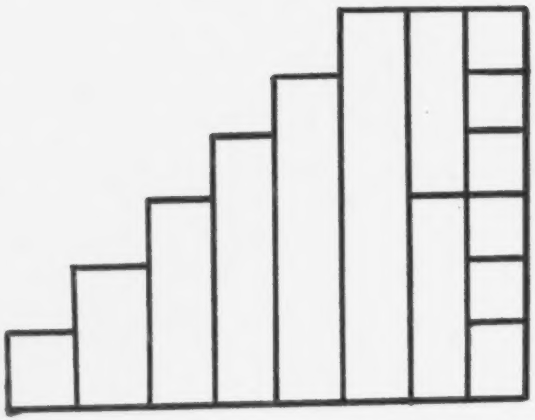
))

MOVE 3 SMALLER PIECES SIDE WAYS, KEEPING THEM AGAINST THE GROUND, AND TAKE THE TWO #3 PIECES OFF AND PUT THESE NEXT TO STEP 6. SEE FIGURE ON FOLLOWING PAGE.

Okay, (POINT TO 2 LARGER EXTRA PIECES BY #6) it takes 2 of the 3rd step to make the 6th step (RUN FINGER OVER ALL OF #6) and it takes 3 (COUNT AS YOU REMOVE EACH SMALLER PIECE FROM STEP 3) like the 1st step to make up the 3rd step (POINT).

11. (CHILD'S NAME), how many of the 1st step (POINT) do we need to make up the 6th step (POINT)?...

MAKE SURE CHILD ADDS 3 MORE SMALLER PIECES ABOVE 3 ALREADY THERE.



Let's check. Use the smaller extra pieces (POINT TO PILE) to see how many pieces like the 1st step it will take to make the 6th step. (POINT TO 3 BY BOTTOM LARGER EXTRA PIECES.) Here are 3 pieces but we'll need more. (HELP CHILD PUT 3 MORE IN PLACE.) How many did it take altogether to make the 6th step.... Let's count them (POINT) 1, 2, 3...6. Very good, so it takes 6 of the 1st step to make the 6th step.

(POINT TO 2 LARGER EXTRA PIECES.) It takes 2 pieces like the 3rd step (POINT) to make the 6th step (POINT).

(POINT TO BOTTOM SMALLER EXTRA PIECES.) It takes 3 of the 1st step to make the 3rd step (POINT TO BOTTOM LARGER PIECES).

12. Then, (CHILD'S NAME), how much is 3 two times?...

((

IF CHILD FAILS TO SAY "SIX:"

12a. Let's count 3 two times. (POINT TO 1 OF THE LARGER EXTRA PIECES.) Here is one 3. We call it a 3 because it equals the 3 smaller pieces beside it (POINT). (POINT TO OTHER LARGER PIECE.) Here is the second 3. We call it a 3 beacuse it also equals the 3 smaller pieces beside it (POINT). To find out how much 3 is two times, we must count the smaller pieces beside each of the larger pieces. Count all of the smaller pieces: 1, 2, ... 6.

Okay, so how much is 3 two times?...

(IF CHILD FAILS, REPEAT 12a.)

))

Very good. Two times 3 equals 6.

REMOVE ALL EXTRA PIECES. PRESENT FELT PIECES FOR STEPS 7-10. USE NEW CHILD FOR EACH STEP.

Here are some more steps. Let's make the stairway bigger. We'll take turns. Remember the steps go from smallest to tallest.

13. (CHILD'S NAME), put in the next step. (REPEAT WITH NEW CHILD UNTIL STAIRWAY IS FINISHED.)

((

IF ANY CHILD FAILS, HAVE HIM COMPARE HIS PIECE WITH REMAINING PIECES.

13a. (POINT TO CHILD'S PIECE.) Is this the smallest piece of those not in the stairway yet?... (PUT HIS PIECE AGAINST REMAINING PIECES.) No! Which is smallest?... Then it should be the next step.

NOTE: RETURN TO PHASE 13 UNTIL STAIRWAY IS COMPLETED.

))

REPEAT QUESTION POINTING TO STEP #3, 6, 5, 8, AND 10. USE NEW (DIFFERENT) CHILD FOR EACH STEP.

14. (CHILD'S NAME), how many steps are there?... Count them... 1, 2, 3, ... 10. Very good, there are 10 steps.

15. (POINT TO 1st STEP.) (CHILD'S NAME), how many pieces like this step can we make out of this step?... (POINT TO EACH STEP--3, 6, 5, 8, 10--ONE AT A TIME USING NEW CHILD FOR EACH STEP.)

((

IF ANY CHILD FAILS, CHECK FOR MISTAKES BY USING SMALLER EXTRA PIECES. REMEMBER TO REMOVE PIECES BEFORE GOING ON TO NEXT STEP.

15a. Let's put on the smaller extra pieces and see... count the pieces. One..., yes, we can make ___ pieces like the 1st step.

))

DISARRANGE THE 10 STEPS.		Very good! Now I'm going to mix up the stair steps and see if you can tell which is which, okay?
REPEAT QUESTION POINTING TO STEPS 3, 7, 6, 8, AND 10. USE NEW CHILD FOR EACH STEP.	16.	(CHILD'S NAME), which step is this (PUT CLOTHES PIN ON EACH STEP -- 3, 7, 6, 8, and 10 -- ONE AT A TIME, USING ONE CHILD FOR EACH STEP)?...

((

IF ANY CHILD FAILS:	16a.	Count the steps with me from smallest to tallest as I point to them. (TEACHER POINTS TO STEPS IN CORRECT ORDER, COUNTING OUT LOUD.) Now you count them from smallest to tallest by yourself.

NOTE: REPEAT PHASE 16a UNTIL CHILD CAN COUNT STEPS IN CORRECT ORDER.

Then this one is #___.

))

Training Log: Cardination

Part I

Subject No.______ School____________________ Date:_________________________

Experimenter_____________________ Observer_____________________

Child's #

______	1.	Block Stairway:	Step 1	P	F
______			2	P	F
______			3	P	F
______			4	P	F
______			5	P	F
______	2.	How many steps ______		P	F
______	3.	How many blocks	# 1	P	F
______			2	P	F
______			3	P	F
______			4	P	F
______			5	P	F
______	4.	3rd over 2nd		P	F
______	5.	How many more		P	F
______	6.	3rd step to 5th		P	F

Part II

Child's #

______	1.	Make Stairway:	Step #2	P	F			
______			3	P	F			
______			4	P	F			
______			5	P	F			
______			6	P	F			
______	2.	How many in 2		P	F	2R.	P	F
______	3.	How many in 3		P	F	3R.	P	F
______	4.	Which step is (6th)		P	F			
______	5.	How many to (6th)		P	F			
______	6.	How many in (6th)		P	F	6R.	P	F
______	7.	How many 3rd in #6		P	F	7R.	P	F
______	8.	Ones in #3		P	F			
______	9.	Ones in 3rd piece		P	F			
______	10.	3rd into 6th		P	F			
______	11.	Ones in #6		P	F			
______	12.	Three two times		P	F			

______	13.	Extend Stairway	# 7	P	F
______			8	P	F
______			9	P	F
______			10	P	F
______	14.	How many steps		P	F
______	15.	Ones in	# 3	P	F
______			6	P	F
______			5	P	F
______			8	P	F
______			10	P	F
______	16.	Which step	# 3	P	F
______			7	P	F
______			6	P	F
______			8	P	F
______			10	P	F

Appendix V

Group Training: Additive Composition of Classes

Part I

Materials needed: 8 round yellow beads, 8 round green beads, 5 square blue beads, wire, checking instrument, basket, paper clip

Procedures:	Phase	Instructions and Questions
PRESENT 2 ROUND YELLOW BEADS, 8 ROUND GREEN BEADS AND 5 SQUARE BLUE BEADS IN BASKET.		Here are some yellow, green and blue beads. Some are round and some are square. Okay?...
BEGIN WITH ONE CHILD AND ASK:	1.	(CHILD'S NAME), are there more green beads or more round beads?... What do the rest of you think?...
PRESENT CHECKING INSTRUMENT. HAVE CHILD PUT ALL THE GREEN BEADS IN A ROW. WITHOUT REMOVING THE GREEN BEADS HAVE CHILD PUT 2 YELLOW BEADS AT THE END.		Let's check and see if you're right. Put the green beads in a row. (HELP IF HE HAS TROUBLE.) See, they come out to here (POINT)... Now let's put all the round beads in a row.

((

IF CHILD FAILS: 1a. Are the green beads round?... Of course; so we must keep them here. Are there any other round beads?...

xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

IF CHILD FAILS: 1b. Let's look at the yellow beads... Are they round?... Of course they are.

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Okay, then we must put them in a row too.

))

2. So, the round beads come out to here (DEMONSTRATE) and the green beads come out to here (POINT)... Do the green beads or the round beads come out farther? ... What do the rest of you think?...

((

IF CHILD FAILS:

2a. (INDICATE STARTING POINT OF GREEN BEADS.) The green beads start here and come out to here (POINT). The green and yellow beads are round. The round beads also start here (POINT) and come out to the end of the yellow ones.

Then are there more green beads, or more round ones?...

(IF CHILD FAILS AGAIN, REPEAT 2a.)

))

Yes, there are more round beads. Very good!

TAKE BEADS OUT OF CHECKING INSTRUMENT AND PLACE ALL BEADS (BLUE, YELLOW, GREEN) IN BASKET IN FRONT OF CHILDREN. CHANGE TO NEW CHILD.

Okay, (CHILD'S NAME) suppose there's a girl who wants to make a necklace with these beads, but she wants to use just the round ones.

3. What colors will her necklace be?...

((

IF CHILD FAILS:

3a. (POINT TO YELLOW AND GREEN BEADS.) Aren't all of these beads round?...

Then what colors will her necklace of round beads be?...

(REPEAT 3a UNTIL CORRECT.)

))

Of course! A necklace of round beads will be both green and yellow.

ASK NEW CHILD:

4. (CHILD'S NAME), which would be longer, the necklace of round beads or the one of green beads?... What do the rest of you think?...

TAKE OUT WIRE.

PLACE PAPER CLIP ON WIRE AT END OF GREEN BEADS.

Let's check to see which would be longer. We'll make a necklace with this wire. Put the green beads on the wire... Okay, the necklace of green beads is this long. We'll mark it with this paper clip... Now let's put all the round beads on the wire...

((

IF CHILD FAILS:

4a. Are the green beads round?... Of course, so we must keep them here. Are there any other round beads?...

xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

IF CHILD FAILS:

4b. Let's look at the yellow beads. Are they round?... Of course they are.

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Okay, then to make the necklace of round beads we have to add the yellow beads on the wire. (HAVE CHILD DO SO.)

))

Now, the necklace of round beads is this long (DEMONSTRATE)... and the necklace of green beads is this long (POINT).

5. Which is longer, the necklace of green beads or the necklace of round beads?... What do the rest of you think?...

((

IF CHILD FAILS:

5a. (INDICATE STARTING POINT OF GREEN BEADS.) The green beads start here and come out to here (POINT). The green and yellow beads are round. The round beads also start here (POINT) and come out to the end of the yellow ones (POINT).

Then which is longer, the necklace of green beads or the necklace of round ones?...

(IF CHILD FAILS AGAIN, REPEAT 5a.)

))

Yes, the necklace of round beads is longer. Very good!

PRESENT 2 ROUND GREEN BEADS, 8 ROUND YELLOW BEADS, AND 5 SQUARE BLUE BEADS IN BASKET.

Here are some yellow, green, and blue beads. Some are round and some are square.

ASK NEW CHILD:

6. (CHILD'S NAME), are there more yellow beads or more round beads?... What do the rest of you think?...

PRESENT CHECKING INSTRUMENT. HAVE CHILD PUT ALL THE YELLOW BEADS IN A ROW. WITHOUT REMOVING THE YELLOW BEADS HAVE CHILD PUT 2 GREEN BEADS AT THE END.

Let's check and see if you're right. Put the yellow beads in a row... (HELP IF HE HAS TROUBLE.) See, they come out to here (POINT)... Now let's put all the round beads in a row.

((

IF CHILD FAILS: 6a. Are the yellow beads round?... Of course; so we must keep them here. Are there any other round beads?...

xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

IF CHILD FAILS: 6b. Let's look at the green beads... Are they round?... Of course they are.

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Okay, then we must put them in a row too.

))

7. So, the round beads come out to here (DEMONSTRATE). And the yellow beads come out to here (POINT)... Do the yellow beads or the round beads come out farther?... What do the rest of you think?...

((

IF CHILD FAILS: 7a. (INDICATE STARTING POINT OF YELLOW BEADS.) The yellow beads start here and come out to here (POINT). The yellow and green beads are round. The round beads also start here (POINT) and come out to the end of the green beads.

Then are there more yellow beads, or more round ones?...

(IF CHILD FAILS AGAIN, REPEAT 7a.)

))

		Yes, there are more round ones. Very good!
TAKE BEADS OUT OF CHECKING INSTRUMENT AND PLACE ALL BEADS (BLUE, YELLOW, GREEN) IN BASKET IN FRONT OF CHILDREN. CHANGE TO NEW CHILD.		Okay, (CHILD'S NAME) suppose there's a girl who wants to make a necklace with these beads, but she wants to use just the round ones.
	8.	What colors will her necklace be?...

((

IF CHILD FAILS:	8a.	(POINT TO YELLOW AND GREEN BEADS.) Aren't all of these beads round?...
		Then what colors will her necklace of round beads be?...
		(REPEAT 8a UNTIL CORRECT)

))

		Of course! A necklace of round beads will be both yellow and green.
ASK NEW CHILD:	9.	(CHILD'S NAME), which would be longer, the necklace of round beads or the one of yellow beads?... What do the rest of you think?...
TAKE OUT WIRE. PLACE PAPER CLIP ON WIRE AT END OF YELLOW BEADS.		Let's check to see which would be longer. We'll make a necklace with this wire. Put the yellow beads on the wire... Okay, the necklace of yellow beads is this long. We'll mark it with this paper clip... Now let's put all the round beads on the wire.

((

IF CHILD FAILS: 9a. Are the yellow beads round?... Of course, so we must keep them here. Are there any other round beads?...

xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

IF CHILD FAILS: 9b. Let's look at the green beads. Are they round?... Of course they are.

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Okay, then to make the necklace of round beads we have to add the green beads on the wire. (HAVE CHILD DO SO.)

))

Now, the necklace of round beads is this long (DEMONSTRATE) and the necklace of yellow beads is this long (INDICATE LENGTH OF NECKLACE).

10. Which is longer, the necklace of yellow beads or the necklace of round beads?... What do the rest of you think?...

((

IF CHILD FAILS: 10a. (INDICATE STARTING POINT OF YELLOW BEADS.) The yellow beads start here and come out to here (POINT). The yellow and green beads are round. The round beads also start here (POINT) and come out to the end of the green ones.

Then which is longer, the necklace of yellow beads or the necklace of round ones?...

(IF CHILD FAILS AGAIN, REPEAT 10a).

))

TAKE BEADS FROM WIRE AND PLACE 2 GREEN, 8 YELLOW, 5 BLUE BEADS IN BASKET IN FRONT OF CHILDREN.

Now let's look at the round beads and the wooden beads.

PICK NEW CHILD AND ASK:

11. (CHILD'S NAME), are there more round beads or more wooden beads?... What do the rest of you think?...

PRESENT CHECKING INSTRUMENT.

Let's check to see if you are right. First put all the round beads in a row.

((

IF CHILD FAILS:

11a. (POINT.) Aren't these beads round too?... Then we'll have to put these in the row too.

))

SAY TO CHILD:

The round beads come out this far (POINT). Now let's make a row of all the wooden beads. Are the round beads wooden?... Yes, so we have to keep them in the row. Are there any other wooden beads?... What do the rest of you think?...

((

IF CHILD FAILS:

11b. Look at the blue square beads. Aren't they wooden too?... Of course they are.

))

So we must put the blue wooden beads in the row too. Now, see, the round beads start here (POINT) and come out to here (POINT). Since the round beads are wooden the wooden beads start here (POINT) and come all the way to here (POINT).

ASK CHILD: 12. Are there more wooden beads, or more round beads?... What do the rest of you think?...

((

IF CHILD FAILS: 12a. (INDICATE STARTING POINT OF ROUND BEADS.) The round beads start here and come to here (POINT). Since the round and square beads are wooden, the wooden beads also start here (POINT) and come to the end of the square beads.

Then are there more round beads or more wooden ones?

(IF CHILD FAILS, REPEAT 12a.)

))

Yes, there are more wooden beads... Very good.

REMOVE BEADS FROM CHECKING INSTRUMENT AND PLACE BEADS IN BASKET IN FRONT OF NEW CHILD AND ASK:

Okay, suppose a girl wants to make a necklace out of all the wooden beads.

13. (CHILD'S NAME), what colors will her necklace be?... What do the rest of you think?...

((

IF CHILD FAILS: 13a. (POINT TO EXCLUDED BEADS.) Aren't these beads made of wood too?... So then what colors will her necklace of wooden beads be?...

(REPEAT 13a UNTIL CORRECT.)

))

Of course, the necklace of wooden beads will be green, yellow, and blue.

ASK NEW CHILD:

14. (CHILD'S NAME), which necklace would be longer, the necklace made of round beads or the necklace made of wooden beads?... What do the rest of you think?...

TAKE OUT WIRE FOR CHILD TO STRING BEADS.

Let's check to make sure. First make the necklace of round beads.

((

IF CHILD FAILS:

14a. (POINT TO EXCLUDED BEADS.) Aren't these beads round too?... Of course, then let's put them on the wire.

))

PLACE PAPER CLIP ON WIRE AT END OF ROUND BEADS.

Okay, the round beads make a necklace this long. We'll mark it with this paper clip. Now let's make the necklace of wooden beads... Are the round beads wooden?... Yes, of course. Are there any other beads that are wooden?... What do the rest of you think?...

((

IF CHILD FAILS:

14b. Are the square beads wooden?... Yes, they are also made of wood.

))

Then we must put the square beads on the necklace too...

Let's first look at the necklace of round beads. It's only this long (POINT) but the necklace of wooden beads is this long (INDICATE LENGTH OF NECKLACE).

ASK CHILD: 15. Which necklace is longer, the necklace of wooden beads or the necklace of round beads?... What do the rest of you think?...

((

IF CHILD FAILS: 15a. (INDICATE STARTING POINT OF ROUND BEADS.) The round beads start here and come to here (POINT). Since the round and square beads are also wooden, the wooden beads also start here (POINT) and come to the end of the square beads.

(IF CHILD FAILS, REPEAT 15a.)

))

Part II

Materials needed: 8 orange rhythm sticks, 8 blue rhythm sticks, and 4 blue blocks

Procedures: Instructions and Questions

Phase

PRESENT 2 BLUE RHYTHM STICKS AND 8 ORANGE RHYTHM STICKS.

Okay, here are some orange and blue wooden sticks.

1. (CHILD'S NAME), are there more orange sticks or more wooden sticks?... What do the rest of you think?...

Let's check to see if you're right. First, let's put all the orange sticks in a row here on the table... Okay, the orange sticks make a row this big (POINT). Now let's make a row of all the wooden sticks.

((

IF CHILD FAILS: 1a. Are the orange sticks wooden?... Of course. Then we must keep them in the row. Are there any other wooden sticks?... What do the rest of you think?...

xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

IF CHILD FAILS: 1b. Are these blue sticks wooden?... Yes, of course they are!

oooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooo

Then let's put them into the row with the orange sticks.

))

2. Now the wooden sticks make a row this big (POINT). And the orange sticks make a row this big (POINT). Are there more orange sticks or more wooden sticks?... What do the rest of you think?...

((

IF CHILD FAILS: 2a. (INDICATE STARTING POINT OF ORANGE STICKS.) The orange sticks start here and come to here (POINT). The orange and blue sticks are wooden. The wooden sticks also start here (POINT) and come to here (POINT). Then are there more orange sticks or more wooden sticks?...

(IF CHILD FAILS REPEAT PHASE 2a.)

))

Very good! There are more wooden sticks.

REMOVE 6 OF THE ORANGE STICKS AND ADD 6 MORE BLUE STICKS.

Now we're going to change some of our sticks. We'll put in more blue sticks. See?

SELECT NEW CHILD:

3. (CHILD'S NAME), now are there more blue sticks or more wooden sticks?... What do the rest of you think?...

Let's check to see if you're right. First let's put all the blue sticks in a row here on the table... The blue sticks make a row this big (POINT)... Now let's make a row of all the wooden sticks.

((

IF CHILD FAILS:

3a. Are the blue sticks wooden?... Of course. Then we must keep them in the row. Are there any other wooden sticks?... What do the rest of you think?...

xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

IF CHILD FAILS:

3b. Are these orange sticks wooden?... Yes, of course they are!

oooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooooo

Then they must go into the row with the blue sticks.

))

4. Now the blue sticks make a row this big (POINT). And the wooden sticks make a row this big (POINT). Are there more blue sticks or more wooden sticks?... What do the rest of you think?...

((

IF CHILD FAILS:

4a. (INDICATE STARTING POINT OF BLUE STICKS.) The blue sticks start here and come to here (POINT).

The blue and orange sticks are wooden. The wooden sticks also start here (POINT) and come to here (POINT). Then are there more blue sticks or more wooden sticks?...

(IF CHILD FAILS REPEAT PHASE 4a.)

))

Yes, very good. There are more wooden sticks.

PRESENT 4 WOODEN BLOCKS, 8 BLUE AND 2 ORANGE STICKS.

Here are some wooden blocks to go with the sticks.

SELECT NEW CHILD:

5. (CHILD'S NAME), now let's look at all the things together. Do we have more wooden *sticks* or more wooden *things*?... What do the rest of you think?...

Let's check and see. First put all the sticks together in a row here on the table... Now let's put all the wooden things together.

((

IF CHILD FAILS:

5a. Are all the sticks wooden?... Yes, of course they are. Are there any other wooden things?... What do the rest of you think?...

xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

IF CHILD FAILS:

5b. Are the blocks wooden?... Yes, of course they are.

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Then they must go with the sticks to make a group of all the wooden things.

))

6. Now can you tell me, are there more wooden sticks or more wooden things?... What do the rest of you think?...

((

IF CHILD FAILS:

6a. (INDICATE STARTING POINT OF WOODEN STICKS.) The wooden sticks start here and come to here (POINT). The sticks and blocks are wooden (POINT). The wooden things also start here (POINT) and come to here (POINT). Then are there more wooden sticks or more wooden things?...

(IF CHILD FAILS, REPEAT PHASE 6a.)

))

REMOVE STICKS AND BLOCKS FROM GROUPING AND DISARRANGE IN FRONT OF NEW CHILD.

Now let's look at all the blue things and all the wooden things.

7. (CHILD'S NAME), now I want you to tell me, do we have more blue things or more wooden things?... What do the rest of you think?...

Let's check and see if you are right. First let's make a group of all the blue things... Very good!

MOVE ORANGE STICKS OVER SO THAT ALL THINGS ARE TOGETHER.

Now let's put all the wooden things together...

((

IF CHILD FAILS:

7a. Are all the sticks wooden?... Yes, of course they are. Are there any other wooden things?... What do the rest of you think?...

xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

IF CHILD FAILS: 7b. Are the blocks wooden?... Yes, of course they are.

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Then they must go with the sticks to make a group of all the wooden things.

))

8. Now are there more blue things or wooden things?...

((

IF CHILD FAILS: 8a. Show me the blue things... they are all wooden...
Show me the orange things... they are wooden too.
All of the things are wooden and only some are blue.
Are there more blue things or more wooden things?...

))

Very good, there are more wooden things.

Training Log: Additive Composition of Classes

Subject No.______ School____________________ Date:____________________

Experimenter___________________ Observer___________________

Part I

Child:

1.	_____	1.	Green or round?	P	F
		2.	Green or round?	P	F
2.	_____	3.	Necklace color?	P	F
3.	_____	4.	Necklace length?	P	F
		5.	Necklace length?	P	F
4.	_____	6.	Yellow or round?	P	F
		7.	Yellow or round?	P	F

Child:

5.	_____	8.	Necklace color?	P	F
6.	_____	9.	Necklace length?	P	F
		10.	Necklace length?	P	F
7.	_____	11.	Round or wooden?	P	F
		12.	Wooden or round?	P	F
8.	_____	13.	Necklace color?	P	F
9.	_____	14.	Necklace length?	P	F
		15.	Necklace length?	P	F

Part II

Child:

1.	_____	1.	Orange or wooden?	P	F
		2.	Orange or wooden?	P	F
2.	_____	3.	Blue or wooden?	P	F
		4.	Blue sticks or wooden sticks?	P	F

Child:

3.	_____	5.	Sticks or wooden things?	P	F
		6.	Sticks or wooden things?	P	F
4.	_____	7.	Blue things or wooden things?	P	F
		8.	Blue things or wooden things?	P	F

Appendix W

Analyses Summary Tables for Experiments I-V

Table I.1. Summary of analysis of covariance of the transformed performance scores for the five treatment groups on DQ.

Source	df	MS	F
Total	48		
Within	44	434.02	
Treatments	4	6404.45	14.76**

$^{**}p < .01$

Table I.2. Summary of analysis of covariance of the transformed performance scores for the five treatment groups on Corr.

Source	df	MS	F
Total	48		
Within	44	380.09	
Treatments	4	1661.03	4.37**

$^{**}p < .01$

Table I.3. Summary of analysis of covariance of the transformed performance scores for the five treatment groups on CQ.

Source	df	MS	F
Total	48		
Within	44	993.39	
Treatments	4	7534.21	7.58**

$^{**}p < .01$

Table I.4. Summary of analysis of covariance of the transformed weighted means of the three posttests for the five treatment groups.

Source	df	MS	F
Total	48		
Within	44	221.36	
Treatments	4	3034.54	13.71**

**p < .01

Table I.5. Summary of repeated measures analysis of variance of the transformed scores for the three pretests.

Source	df		MS	F
Between	49			
Within	100			
Pretests		2	5267.72	15.49**
Residual		98	340.06	
Total	149			

**p < .01

Table II.1. Summary of treatment x levels analysis of variance, adjusted for disproportionate numbers, of the transformed DQ posttest scores for the two treatment groups.

Source	df	MS	F
Treatments	1	10439.90	50.92**
Levels	2	6273.38	30.60**
Interaction	2	5922.04	28.88**
Within	65	205.04	
Total	70		

**p < .01

Table II.2. Summary of treatment x levels analysis of variance, adjusted for disproportionate numbers, of the transformed Corr posttest scores for the two treatment groups.

Source	df	MS	F
Treatments	1	3595.28	22.12**
Levels	2	5792.80	35.64**
Interaction	2	947.38	5.83**
Within	66	162.54	
Total	71		

**p < .01

Table II.3. Summary of treatment x levels analysis of variance, adjusted for disproportionate numbers, of the transformed CQ posttest scores for the two treatment groups.

Source	df	MS	F
Treatments	1	14540.13	41.73**
Levels	2	6970.55	20.00**
Interaction	2	5700.20	16.36**
Within	65	348.45	
Total	70		

**p < .01

Table II.4. Summary of treatment x levels analysis of variance, adjusted for disproportionate numbers, of the transformed O posttest scores for the two treatment groups.

Source	df	MS	F
Treatments	1	4378.91	17.67**
Levels	2	2216.67	8.95**
Interaction	2	191.41	.77
Within	65	247.81	
Total	70		

**p < .01

Table II.5. Summary of treatment x levels analysis of variance, adjusted for disproportionate numbers, of the transformed C posttest scores for the two treatment groups.

Source	df	MS	F
Treatments	1	3955.19	11.00**
Levels	2	7987.12	22.22**
Interaction	2	941.07	2.62
Within	65	359.46	
Total	70		

**$p < .01$

Table II.6. Summary of treatment x levels analysis of variance, adjusted for disproportionate numbers, of the transformed ACC posttest scores for the two treatment groups.

Source	df	MS	F
Treatments	1	56919.70	292.48**
Levels	2	564.22	2.90
Interaction	2	263.44	1.35
Within	65	194.61	
Total	70		

**$p < .01$

Table II.7. Summary of repeated measures analysis of variance of the transformed performance scores for the six pretests.

Source	df		MS	F
Between	70			
Within	355			
Pretests		5	9316.04	19.27**
Residual		350	483.48	
Total	425			

**$p < .01$

Table III.1. Summary of analysis of covariance of the transformed performance scores for the four treatment groups on DQ.

Source	df	MS	F
Total	34		
Within	31	427.83	
Treatments	3	941.75	2.20

Table III.2. Summary of analysis of covariance of the transformed performance scores for the four treatment groups on Corr.

Source	df	MS	F
Total	34		
Within	31	334.95	
Treatments	3	1535.30	4.58**

**$p < .01$

Table III.3. Summary of analysis of covariance of the transformed performance scores for the four treatment groups on CQ.

Source	df	MS	F
Total	34		
Within	31	734.47	
Treatments	3	3340.00	4.55**

**$p < .01$

Table III.4. Summary of analysis of covariance of the transformed weighted means of the three posttests for the four treatment groups.

Source	df	MS	F
Total	34		
Within	31	258.77	
Treatments	3	1352.85	5.23**

**$p < .01$

Table III.5. Summary of repeated measures analysis of variance of the transformed performance scores for the three pretests.

Source	df		MS	F
Between	35			
Within	72			
Pretests		2	2287.00	6.72**
Residual		70	340.43	
Total	107			

**$p < .01$

Table IV.1. Summary of analysis of covariance of the transformed performance scores for the four treatment groups on DQ.

Source	df	MS	F
Total	63		
Within	60	628.2[illegible]	
Treatments	3	2265[illegible]8	3.61*

*$p < .05$

Table IV.2. Summary of analysis of covariance of the transformed performance scores for the four treatment groups on Corr.

Source	df	MS	F
Total	63		
Within	60	260.44	
Treatments	3	441.50	1.70

Table IV.3. Summary of analysis of covariance of the transformed performance scores for the four treatment groups on CQ.

Source	df	MS	F
Total	63		
Within	60	1398.28	
Treatments	3	4877.85	3.49*

$^{*}p < .05$

Table IV.4. Summary of analysis of covariance of the transformed performance scores for the four treatment groups on O.

Source	df	MS	F
Total	63		
Within	60	406.65	
Treatments	3	1941.77	4.78**

$^{**}p < .01$

Table IV.5. Summary of analysis of covariance of the transformed performance scores for the four treatment groups on C.

Source	df	MS	F
Total	63		
Within	60	594.59	
Treatments	3	3107.65	5.23**

**p < .01

Table IV.6. Summary of analysis of covariance of the transformed performance scores for the four treatment groups on ACC.

Source	df	MS	F
Total	63		
Within	60	255.77	
Treatments	3	2599.86	10.17**

**p < .01

Table IV.7. Summary of repeated measures analysis of variance of the transformed performance scores for the six pretests.

Source	df		MS	F
Between	64			
Within	325			
Pretest		5	4542.61	9.40**
Residual		320	483.09	
Total	389			

**p < .01

Table IV.8. Summary of analysis of covariance of the transformed performance scores for the four treatment groups on DQ.

Source	df	MS	F
Total	26		
Within	23	568.21	
Treatments	3	772.58	1.36

Table IV.9. Summary of analysis of covariance of the transformed performance scores for the four treatment groups on Corr.

Source	df	MS	F
Total	26		
Within	23	220.55	
Treatments	3	914.13	4.14*

*$p < .05$

Table IV.10. Summary of analysis of covariance of the transformed performance scores for the four treatment groups on CQ.

Source	df	MS	F
Between	26		
Within	23	1044.32	
Treatments	3	3559.25	3.41*

*$p < .05$

Table IV.11. Summary of analysis of covariance of the transformed performance scores for the four treatment groups on O.

Source	df	MS	F
Between	26		
Within	23	501.23	
Treatments	3	1067.01	2.13

Table IV.12. Summary of analysis of covariance of the transformed performance scores for the four treatment groups on C.

Source	df	MS	F
Between	26		
Within	23	412.15	
Treatments	3	787.95	1.91

Table IV.13. Summary of analysis of covariance of the transformed performance scores for the four treatment groups on ACC.

Source	df	MS	F
Between	26		
Within	23	224.15	
Treatments	3	1695.30	7.56**

**$p < .01$

Table IV.14. Summary of repeated measures analysis of variance of the transformed performance scores for the six pretests.

Source	df	MS	F
Between	27		
Within	140		
Posttests	5	1866.81	3.61**
Residual	135	516.92	
Total	167		

**p < .01

Table V.1. Summary of analysis of covariance of the transformed performance scores for the two treatment conditions on DQ.

Source	df	MS	F
Total	31		
Within	30	735.82	
Treatments	1	4610.09	6.27*

*p < .05

Table V.2. Summary of analysis of covariance of the transformed performance scores for the two treatment conditions on Corr.

Source	df	MS	F
Total	31		
Within	30	407.37	
Treatments	1	461.08	1.13

Table V.3. Summary of analysis of covariance of the transformed performance scores for the two treatment conditions on CQ.

Source	df	MS	F
Total	31		
Within	30	1368.40	
Treatments	1	3847.60	2.81

Table V.4. Summary of analysis of covariance of the transformed performance scores for the two treatment conditions on O.

Source	df	MS	F
Total	36		
Within	35	457.27	
Treatments	1	1245.86	3.57**

**$p < .01$

Table V.5. Summary of analysis of covariance of the transformed performance scores for the two treatment conditions on C.

Source	df	MS	F
Total	36		
Within	35	265.03	
Treatments	1	847.93	3.20*

*$p < .05$

Table V.6. Summary of analysis of covariance of the transformed performance scores for the two treatment conditions on ACC.

Source	df	MS	F
Total	36		
Within	35	219.03	
Treatments	1	145.71	.66

Table V.7. Summary of repeated measures analysis of variance of the transformed performance scores for the six pretests.

Source	df		MS	F
Between	37			
Within	190			
Pretest		5	4823.39	
Residual		185	369.99	13.04**
Total	227			

**$p < .01$

Appendix X

Original Data for Experiments I through V

Key:

(1) Subject Number
(2) Sex: F = Female, M = Male
(3) Chronological Age
(4) Mental Age
(5) Intelligence Quotient
(6) DQ Pretest - percentage correct
(7) DQ Posttest - percentage correct
(8) DQ Immediate Posttest - percentage correct
(9) Corr Pretest - percentage correct
(10) Corr Posttest - percentage correct
(11) Corr Immediate Posttest - percentage correct
(12) CQ Pretest - percentage correct
(13) CQ Posttest - percentage correct
(14) CQ Immediate Posttest - percentage correct
(15) O Pretest - percentage correct
(16) O Posttest - percentage correct
(17) O Immediate Posttest - percentage correct
(18) C Pretest - percentage correct
(19) C Posttest - percentage correct
(20) C Immediate Posttest - percentage correct
(21) ACC Pretest - percentage correct
(22) ACC Posttest - percentage correct
(23) ACC Immediate Posttest - percentage correct
(24) Weighted Total Pretest - percentage correct
(25) Weighted Total Posttest - percentage correct
(26) Mathematics, Form 12A (1)
(27) Mathematics, Form 12B
(28) Mathematics, Form 12A (2)
(29) DQ Delayed Posttest - percentage correct
(30) Corr Delayed Posttest - percentage correct
(31) CQ Delayed Posttest - percentage correct
(32) O Delayed Posttest - percentage correct
(33) C Delayed Posttest - percentage correct
(34) ACC Delayed Posttest - percentage correct
(35) Extent of Retardation:
  E = Educable
  T = Trainable

Experiment I

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(24)	(25)
DQ Training Group															
102	F	11.66	8.63	74	13	100	100	8	75		00	100		8	88
111	M	9.58	7.47	78	13	100	100	17	58		00	00		12	58
311	F	11.50	9.20	80	71	100	100	83	92		00	100		60	96
313	F	9.00	6.03	67	50	100	86	67	83		17	67		50	85
409	F	10.17	6.31	62	13	100	86	17	92		00	100		12	96
417	F	7.91	5.62	71	00	86	100	00	83		00	83		00	84
505	F	7.91	5.93	75	17	100	100	33	100		00	100		21	100
513	M				13	100	100	42	50		00	100		23	77
611	M	9.75	6.44	66	00	100	100	8	75		00	100		4	88
713	M				13	100	100	8	67		00	100		8	85
718	F	11.75	10.69	91	50	100	100	92	100		00	100		58	100
Corr Training Group															
109	F	11.33	7.59	67	67	100		50	92	92	00	100		42	96
303	M	11.17	9.61	86	100	100		58	92	100	17	100		61	96
408	F	11.17	7.71	69	29	100		33	83	100	17	100		28	92
413	F	9.66	7.05	73	25	100		75	83	100	17	100		46	92
419	M	11.08	8.53	77	75	100		00	100	100	00	67		23	92
428	F	9.91	6.14	62	00	50		00	17	17	00	17		00	27
503	M				33	100		25	50	58	00	100		21	77
609	F	10.00	5.90	59	13	38		00	75	67	17	67		8	62
706	M	12.91	9.55	74	29	100		25	75	100	17	100		24	88
CQ Training Group															
112	M	11.17	7.71	69	33	86		17	75		17	100	17	21	84
308	F	11.08	7.87	71	100	100		33	92		50	17	50	56	77
403	M	10.00	6.40	64	38	100		58	75		50	100	100	50	88
423	M	10.83	7.04	65	63	100		8	58		00	100	100	23	81
612	M	10.00	8.90	89	29	100		17	83		00	100	100	16	92

Experiment I, cont.

CQ Training Group, cont.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(24)	(25)
614	F				00	29		58	75		100	100	100	50	68
701	M				50	100		58	92		00	100	100	42	96
702	M	8.50	6.29	74	25	38		8	8		00	17	100	11	19
709	F	9.91	7.63	77	29	100		33	67		33	100	100	32	85
710	F	10.83	7.25	67	38	100		42	67		33	100	100	39	85
Control Group															
114	M				71	100		67	92		17	100		56	96
212	F	6.66	4.06	61	33	13		00	8		00	00		8	8
305	F	9.83	6.59	67	38	00		17	75		00	00	17	20	35
312	F	9.33	7.00	75	75	100		58	92		33	100	67	57	96
406	F	7.91	6.17	78	38	00		58	67		00	17	00	38	35
415	M	8.41	5.72	68	13	13		8	00		33	00	00	15	4
424	M	9.41	6.02	64	50	38		00	17		00	00	00	15	20
508	M	8.66	6.50	75	75	100		67	83	67	00	100		54	92
613	M	9.58	6.80	71	25	00		67	75		17	00	00	43	35
618	M	9.33	7.18	77	00	00		00	00		00	00	17	00	00
Control Language Group															
101	M	8.91	6.42	72	50	50		17	8		17	00	17	27	17
203	M	8.08	5.82	72	00	38		17	8		17	00		12	15
304	M	9.33	6.62	71	63	100		42	100		67	100	100	54	100
309	F	9.58	7.66	80	100	100		42	75	83	50	100		62	88
404	F	10.17	7.32	72	38	13	50	00	00		50	17		23	8
410	M	10.08	6.65	66	43	17		00	00		00	17	17	12	9
418	M	8.00	6.00	75	00	13		00	00		00	00	00	00	4
502	F	10.66	9.06	85	57	88		92	92		50	50	50	72	81
610	M	10.08	5.14	51	50	13		33	00		00	00	00	31	4
617	M	7.05	5.33	71	25	63	13	00	58		17	00		12	46

Experiment II

Level one, Experimental Group

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(15)	(16)	(17)
108	M	11.25	8.77	78	100	100		92	92		100	100	56	67	
121	M	10.00	9.30	93	100	100		83	83		100	100	89	78	
306	F	10.50	8.30	79	100	100		100	92		100	100	89	100	
310	M	11.83	9.23	78	100	100		83	100		100	100	89	100	
412	F	13.08	10.73	82	100	100		100	100		83	100	100	89	
422	M	11.33	9.06	80	100	100		92	100		100	100	67	100	

Level one, Control Group

103	M	12.92	9.95	77	100	100		100	83		100	100	100	100	
105	M	13.33	10.40	78	100	100		92	92		100	100	100	100	
109	M	13.25	9.94	75	100	100		92	100		100	100	78	33	
119	M	13.08	9.16	70	100	100		100	100		100	100	89	89	
301	M	11.92	9.54	80	100	100		75	100		100	100	78	89	
309	F	9.67	6.87	71	100	100		92	100		100	100	78	89	
416	M	13.25	8.08	61	100	100		100	100		100	100	78	78	
417	M	10.42	8.54	82	100	100		92	92		100	100	67	78	

Level two, Experimental Group

112	M	11.75	7.64	65	100	100		92	67		100	100	22	56	56
114	F	11.58	9.61	83	100	100		100	75		83	100	33	78	78
218	F	10.75	10.21	95	100	100		83	83		100	100	67	67	78
224	F	11.75	9.05	77	100	100		100	92		100	100	89	100	67
312	F	10.75	8.17	76	100	100		92	92		100	100	22	100	100
401	M	12.73	9.42	74	100	100		92	83		100	100	44	89	89
408	M	12.67	9.38	74	100	100		75	75		100	100	11	100	78
411	F	13.00	9.10	70	100	100		83	83		100	100	44	78	100
415	M	12.08	9.30	77	78	100		92	83		83	100	56	89	100
420	F	10.58	8.15	77	100	100		83	67		100	100	67	89	78
426	F	12.08	8.94	74	100	100		83	92		100	100	56	89	89
429	M	9.50	8.74	92	100	100		75	83		100	100	56	78	100

Experiment II, cont.

Level two, Control Group

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(15)	(16)	(17)
107	M	12.08	8.34	69	100	100		83	92		100	100	56	100	78
126	F	9.00	6.57	73	100	100		83	67		100	100	67	89	78
128	M	9.00	6.21	69	100	89		75	83		17	17	22	44	44
215	M	12.50	9.25	74	100	100		92	100		100	100	00	33	67
217	M	11.50	9.20	80	100	100		92	92		100	100	100	78	78
219	F	12.08	8.46	70	100	100		92	100		100	100	56	89	78
221	M	12.50	9.13	73	100	100		83	83		100	100	89	11	78
223	F	11.83	8.75	74	100	100		75	75		100	100	67	56	44
305	F	11.50	8.28	72	100	100		83	83		100	100	56	67	22
313	M	12.75	8.79	69	78	100		83	75		100	100	56	89	89
406	F	12.92	9.43	73	89	100		92	83		100	33	11	67	56
410	M	11.75	8.93	76	100	100		83	100		100	100	56	78	22
419	F	10.08	7.66	76	100	100		83	92		100	100	22	33	89

Level three, Experimental Group

110	M	11.25	8.21	73	88	100	100	75	83	83	100	100	44	100	67
117	M	10.08	7.96	79	11	100	100	25	92	83	00	100	11	78	78
118	F	11.92	7.99	67	56	100	100	58	92	100	33	100	44	78	89
127	M	10.17	8.14	80	33	100	100	8	67	67	00	100	00	78	56
202	M	9.08	5.62	62	11	77	100	25	58	75	50	67	22	44	78
204	F	9.08	7.35	81	00	100	67	42	75	50	00	83	33	89	78
206	M	8.33	5.75	69	44	100	100	17	58	50	00	100	22	33	56
208	M	9.50	6.46	68	89	100	100	75	75	83	33	100	22	78	44
210	M	10.33	6.30	61	00	100	89	17	67	67	00	100	33	67	78
222	M	10.75	7.53	70	11	100	100	8	50	67	00	100	44	44	67
304	F	8.75	6.65	76	44	100	100	75	83	92	67	100	00	89	78
308	F	8.25	6.27	76	22	100	100	25	92	92	33	100	11	100	67
407	F	13.25	8.08	61	33	100	100	33	88	75	00	100	44	67	78
418	F	10.00	7.60	76	67	100	100	67	92	92	33	100	22	56	56
428	F	10.67			33	100	100	17	83	92	00	100	00	89	78

Experiment II, cont.

Level three, Experimental Group, cont.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(15)	(16)	(17)
435	F				11	100	100	25	75	67	00	100	22	56	44
437	F	8.08	7.27	90	11	100	100	33	100	83	00	100	22	100	67
506	M	9.00	7.02	78	11	100	100	42	92	100	00	100	56	78	67

Level three, Control Group

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(15)	(16)	(17)
101	M	12.42	7.70	62	11	33	44	33	42	17	17	100	44	22	33
111	F	11.92	9.42	79	11	100	22	50	83	33	00	100	56	67	89
115	F	7.92	5.07	64	45	11	44	33	00	00	67	50	11	33	11
120	M	9.17	6.60	72	00	78	44	33	58	42	00	83	33	44	22
205	M	9.25	6.48	70	22	11	22	25	58	58	00	17	11	44	56
209	M	7.50	5.55	74	11	00	56	33	33	25	00	00	33	33	56
211	M	10.08	7.06	70	00	00	00	25	8	17	00	17	00	67	22
213	M	12.08	7.37	61	22	11	11	25	33	33	00	00	56	67	78
404	F	13.42	9.26	69	56	100	56	25	42	25	00	00	00	22	11
430	F	8.83	7.24	82	00	44	11	17	50	33	00	00	00	56	56
432	M	8.83	6.62	75	56	78	56	67	92	83	00	67	44	78	33
434	M	8.17	6.54	80	11	11	11	25	8	25	00	00	44	44	22
501	F	7.00	5.88	84	00	33	00	25	17	17	00	00	33	22	00
502	F	7.17	5.95	83	00	00	11	25	58	25	00	17	33	33	22

Level one, Experimental Group, cont. (Variables 18 through 28)

(1)	(18)	(19)	(20)	(21)	(22)	(23)	(26)	(27)	(28)
108	100	100		13	100	100	35	40	43
121	90	100		38	88	88	33	33	
306	70	100		13	100	100	47	40	43
310	80	90		00	100	100	46	48	51

Experiment II, cont.

Level one, Experimental Group, cont. (Variables 18 through 28)

(1)	(18)	(19)	(20)	(21)	(22)	(23)	(26)	(27)	(28)
412	90	100		25	100	100	45	41	
422	90	100		25	100	100	43	40	43

Level one, Control Group, cont. (Variables 18 through 28)

103	70	100		13	25	25	44	42	
105	88	100		13	13	25	00	50	
109	100	100		25	63	25	00	43	
119	100	70		25	13	13	46	48	
301	70	100		25	25	25	45	43	49
309	100	80		00	50	13	47	40	48
416	80	80		25	13	00	49	41	
417	100	90		38	13	13	39	37	45

Level two, Experimental Group, cont. (Variables 18 through 28)

112	10	80	70	25	100	100	00	29	39
114	00	70	90	25	100	100	00	41	43
218	100	80	100	38	100	100	41	45	
224	30	70	100	13	100	100	36	42	
312	50	90	100	13	100	100	00	35	46
401	70	70	100	25	63	100	41	42	
408	80	100	90	25	100	100	46	40	
411	70	80	100	00	100	100	38	32	
415	100	100	70	25	100	100	43	38	43
420	40	80	100	25	100	100	31	36	36
426	60	100	100	13	100	100	34	18	41
429	100	100	80	38	100	100	34	30	43

Experiment II, cont.

Level two, Control Group, cont. (Variables 18 through 28)

(1)	(18)	(19)	(20)	(21)	(22)	(23)	(26)	(27)	(28)
107	00	100	100	25	00	25	42	44	48
126	00	100	80	13	13	25	34	34	42
128	60	70	60	00	13	38	20	28	34
215	70	70	70	25	13	25	32	35	
217	20	60	70	00	25	38	36	31	
219	20	90	90	38	25	13	46	00	
221	20	100	70	25	13	13	43	46	
223	60	90	70	38	25	25	42	36	
305	80	80	60	00	25	38	44	38	45
313	70	100	60	50	13	25	00	40	
406	50	80	60	25	13	25	45	39	
410	70	100	100	38	25	00	40	35	
419	100	100	90	25	13	00	37	45	42

Level three, Experimental Group, cont. (Variables 18 through 28)

110	00	100	100	13	100	100	31	36	48
117	00	10	80	25	88	100	34	27	31
118	80	70	90	63	88	88	25	27	32
127	00	60	70	63	100	100	29	27	32
202	60	70	80	50	88	88	23	24	
204	00	80	70	25	100	100	29	25	
206	00	60	50	38	100	100	20	17	
208	20	00	80	13	100	88	20	33	
210	40	50	70	25	13	88	27	24	
222	50	80	70	13	88	100	35	32	
304	60	100	70	25	63	100	32	31	38
308	30	80	70	38	100	75	00	00	31
407	70	100	70	13	88	100	38	28	
418	30	90	70	38	100	100	35	34	44
428	80	80	60	50	100	100	37	32	26

Experiment II, cont.

Level three, Experimental Group, cont. (Variables 18 through 28)

(1)	(18)	(19)	(20)	(21)	(22)	(23)	(26)	(27)	(28)
435	70	60	90	63	78	25	18	27	40
437	90	100	100	13	88	50	00	22	33
506	10	90	70	00	88	100	30	29	41

Level three, Control Group, cont. (Variables 18 through 28)

101	88	60	70	13	25	25	00	20	
111	30	50	30	00	00	38	39	33	35
115	10	00	10	63	75	25	00	2	20
120	10	60	50	13	00	25	19	27	28
205	70	70	60	38	13	00	26	26	
209	00	00	40	38	13	13	00	00	
211	00	40	10	63	25	25	20	28	
213	30	70	100	25	13	25	29	28	
404	60	80	90	38	13	25	28	27	
430	50	30	50	13	13	13	26	27	34
432	50	10	50	13	13	25	28	21	31
434	70	50	40	63	25	13	34	13	
501	10	10	30	38	50	13	18	22	27
502	00	00	10	25	00	25	24	21	34

Experiment III

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(24)	(25)	(35)
DQ Training Group																
01	M	13.92	5.92	55	33	45	89	8	17		00	33		15	30	T
02	F	14.92	6.50	55	22	100	100	50	83		00	100		30	92	E
03	F	20.75	3.58	23	00	100	100	17	58		33	50		15	70	T
04	M	14.34	11.92	90	56	100	100	25	100		33	100		37	100	E
05	M	12.84	5.33	52	00	100	100	17	100		00	100		8	100	E
06	F	24.75		46	00	100	100	8	75		00	100		4	89	T
07	M	16.09	10.17	71	67	100	100	8	92		00	100		26	96	E
08	M	15.92	5.83	44	00	100	100	42	82		17	100		22	92	T
09	F	31.25		32	78	100	100	17	75		17	83		37	85	T
10	F	25.84			22	100	100	17	92		00	17		15	78	T
11	M	18.50	6.50	55	00	33	100	8	25		00	00		4	22	T
12	M	8.42	3.42	41	67	100	100	50	100		100	100		67	100	E
13	F				11			42			00					E
Corr Training Group																
01	M	13.59	3.50	32	22	89		50	58	83	00	33		30	63	T
02	M	10.84	7.42	72	00			8			00					E
04	M	21.00	7.25	62	11	89		17	50	83	00	100		11	74	T
05	M	12.68	10.75	87	45			27			00					E
06	F	17.92	8.75	59	100	100		83	100	100	100	100		92	100	E
07	M	16.34	6.83	52	78	100		67	100	83	17	17		60	82	E
08	M	15.75	4.75	37	33	100		67	67	75	67	100		56	85	T
10	M	13.00	5.08	50	00			25			17					E
11	F	35.75		39	22	89		8	75	92	00	83		11	81	T
12	F	31.59		49	67	56		13	50	58	100	100		50	63	T
14	F	20.68	4.00	29	33	100		50	83	83	00	50		33	81	T
15	F	21.34	7.25	51	11	100		75	75	83	17	100		41	67	T
CQ Training Group																
01	M	7.25	4.50	69	45	100		00	83		00	100	67	15	92	E

Experiment III, cont.

CQ Training Group, cont.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(24)	(25)	(35)
02	M	14.75	5.67	50	22	100		8	83		00	100	83	11	92	E
03	F	19.68	6.17	43	00	100		00	50		00	33	67	00	63	E
04	M	16.75	6.83	49	33	100		8	100		00	100	83	15	100	E
05	M	10.25	3.33	32	00	100		00	83		00	100		00	92	E
07	M	10.59	7.58	80	22	100		100	100		00	100	100	52	100	E
08	F	14.92	6.83	57	33	45		42	50		50	100		41	59	T
11	F	21.75		59	67	78		58	58		33	100	100	55	74	T
12	F	29.50		56	78	100		50	50		00	100	100	48	78	T
15	F	36.25		30	67	100		42	58		17	100	100	45	81	E

Control Group

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(24)	(25)	(35)
02	F	15.17	6.50	55	67	100	00	42	8		00	00		41	37	E
03	M	15.17	7.42	60	00			17			00					E
04	F	18.84	7.25	51	22			67			00					T
05	F	12.09	4.92	49	11			8			00					T
07	F	19.59	5.25	58	40	100	00	83	75		67	100		65	89	T
08	M	13.50	4.58	46	33	78	00	33	58		67	100		41	74	T
09	F	21.09	5.92	42	11			25			00					T
10	M	13.68	6.67	59	11	11	00	33	17		00	00		18	11	E
11	F	21.25	8.50	58	11			00			00					T
12	M	14.25	10.42	82	11	11	00	25	8		00	00		15	7	T

Experiment IVa

DQ Training Group

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(12)	(13)	(15)	(16)	(17)
101	M	12.92	9.56	74	33	100	100	91	83	00	100	55	88	
103	M	12.92	8.65	67	22	100	100	41	83	33	66	55	77	
106	M	10.50	7.66	73	66	100	100	100	100	66	100	66	100	
107	M	12.09	8.34	69	100	100	100	91	91	00	16	77	77	
120	F	9.43	6.97	74	100	100	100	91	83	100	100	55	88	
205	M	10.59	7.30	69	11	100	100	33	100	00	100	33	100	
210	F	7.67	5.67	74	11	100	100	33	83	00	100	11	66	
215	M	13.09	8.37	64	100	100	100	66	100	00	100	22	88	
224	M	12.75	7.90	62	88	100	100	75	100	50	100	66	100	
310	M	7.43	5.20	70	55	100	100	58	100	00	100	55	22	
314	F	8.75	6.12	70	00	100	100	50	75	00	100	22	33	
321	F	12.50	7.87	63	33	100	100	58	91	16	100	33	66	
505	M	11.09	6.54	59	100	100	100	83	91	100	100	44	100	
511	M	11.43	7.88	69	33	100	100	25	75	00	100	33	66	
520	F	11.67	8.28	71	44	66	77	91	58	00	00	77	55	
526	M	8.17	5.63	69	00	88	44	16	8	00	00	44	00	
530	F	8.25	5.77	70	77	100	100	16	58	16	100	55	55	
O and C Training Group														
102	F	12.75	10.45	82	00	100		75	100	00	100	100	100	100
104	F	13.25	7.95	60	22	88		91	75	100	66	44	88	100
111	M	13.34	9.47	71	44	66		25	41	00	00	88	77	77
122	M	9.00	6.66	74	44	100		16	33	00	00	22	88	66
131	M	9.92	5.75	58	00	100		25	83	33	33	77	66	100
202	M	9.75	5.75	59	44	44		66	83	100	100	100	77	100
208	M	8.50	5.78	68	100	100		75	83	00	83	88	100	100
209	M	7.67	5.67	74	11	11		25	8	00	00	44	88	88
211	F	9.75	6.92	71	100	100		91	100	100	100	44	100	100
216	M	12.67	10.51	83	100	100		75	83	100	100	77	100	100
303	F	9.43	5.56	59	88	22		25	41	00	00	11	44	100

Experiment IVa, cont.

O and C Training Group, cont.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(12)	(13)	(15)	(16)	(17)
306	M	9.00	5.40	60	55	88		91	83	100	100	11	77	100
513	F	10.34	7.65	74	33	44		41	50	33	00	66	100	100
514	F	9.84	6.39	65	44	100		83	100	00	00	77	100	77
516	M	10.25	6.86	67	11	11		50	33	00	00	55	66	88
522	M	10.00	6.30	63	33	33		33	33	16	00	11	77	100

ACC Training Group

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(12)	(13)	(15)	(16)	(17)
109	F	11.17	7.48	67	100	100		91	100	00	100	88	100	
113	F	11.75	7.28	62	44	100		8	83	33	100	44	44	
115	F	12.34	8.02	65	100	100		83	100	100	100	44	88	
118	M	10.25	7.17	70	11	100		58	83	33	100	22	77	
124	F	7.84	5.48	70	11	11		25	41	00	00	44	66	
206	F	9.43	6.31	67	22	88		75	83	00	33	66	100	
207	M	10.25	6.66	65	77	55		8	50	00	00	33	44	
219	F	11.50	7.93	69	11	100		91	100	100	100	44	100	
222	M	10.00	7.20	72	88	100		75	83	11	100	33	33	
304	F	7.84	5.72	73	66	44		58	100	50	00	11	77	
307	M	9.25	6.01	65	22	44		00	8	00	00	00	00	
308	F	10.43	6.57	63	77	100		91	100	100	100	77	77	
515	M	8.84	5.48	62	11	11		25	33	00	00	33	22	
518	M	9.59	5.75	60	1[illegible]	11		25	58	00	00	55	77	
519	F	11.84	6.74	57	33	100		75	100	66	100	44	55	
523	M	10.17	6.50	64	33	33		91	100	00	100	66	88	

Control Group

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(12)	(13)	(15)	(16)	(17)
108	F	11.67	8.98	77	66	88	88	75	91	16	100	100	77	
119	M	8.17	5.80	71	11	11		58	50	83	00	11	11	
126	M	7.50	4.80	64	11	00	11	16	8	16	00	33	33	

Experiment IVa, cont.

Control Group, cont.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(12)	(13)	(15)	(16)	(17)
127	F	11.67	7.35	63	100	100		91	100	100	100	55	22	
129	M	10.43	8.34	80	22	100		83	83	100	83	66	66	66
214	M	11.84	6.15	52	88	100		83	75	00	00	77	55	
218	F	12.17	7.42	61	44	11		33	25	00	00	77	00	
223	M	10.59	8.26	78	11	100	100	50	100	00	100	44	55	
225	F	12.43	7.08	57	11	00		33	25	00	00	33	44	33
226	F	11.92	8.22	69	100	100	100	83	100	16	100	44	100	
309	F	7.75	5.19	67	44	55		75	83	00	00	33	22	
313	F	11.67	8.05	69	77	100		83	100	00	100	66	66	77
318	M	13.17	10.79	82	100	100	100	83	100	100	100	100	88	
512	M	13.43	10.07	75	100	100	100	91	100	100	100	88	66	
524	M	9.34	6.35	68	44	66		25	83	33	50	44	44	
525	M	9.43	6.41	68	33	88		50	66	00	50	55	66	33

DQ Training Group, cont. (Variables 18 through 34)

(1)	(18)	(19)	(20)	(21)	(22)	(23)	(29)	(30)	(31)	(32)	(33)	(34)
101	90	70		70	40							
103	50	70		40	50							
106	50	80		40	50		100	75	100	100	80	100
107	60	80		40	40							
120	10	20		30	100							
205	10	10		40	30		100	92	33	100	30	40
210	10	10		40	40							
215	20	20		20	40							
224	80	70		40	90							
310	20	40		20	10		33	25	00	78	10	30
314	20	40		60	70		22	25	00	100	40	60
321	10	00		50	40							
505	30	100		30	40		100	100	100	67	100	30

Experiment IVa, cont.

DQ Training Group, cont. (Variables 18 through 34)

(1)	(18)	(19)	(20)	(21)	(22)	(23)	(29)	(30)	(31)	(32)	(33)	(34)
511	40	80		40	40							
520	60	70		80	60		33	67	00	56	100	80
526	20	00		40	30		11	17	00	11	10	60
530	40	20		30	50		100	58	100	44	70	80
O and C Training Group, cont. (Variables 18 through 34)												
102	100	100	100	90	100							
104	10	100	100	40	90							
111	00	70	90	50	30							
122	00	90	80	60	50							
131	00	80	100	40	30		100	75	33	100	100	30
202	80	70	100	50	50		78	100	100	78	70	30
208	60	90	100	100	100							
209	10	100	60	50	50							
211	50	100	100	40	80							
216	00	100	90	20	10							
303	40	70	100	50	50		56	42	00	22	60	50
306	20	90	90	40	40		22	83	100	100	90	10
513	100	80	100	30	30		100	50	100	89	100	50
514	20	100	40	70	80							
516	00	70	90	30	30		56	92	00	100	100	50
522	20	70	100	20	30		11	50	17	56	90	40
ACC Training Group, cont. (Variables 18 through 34)												
109	60	100		60	100	100	100	100	100	78	100	100
113	20	10		50	100	100	100	83	83	44	00	100
115	100	100		40	100	100						
118	10	10		80	100	100	100	100	100	67	00	90
124	80	20		30	100	90						

Experiment IVa, cont.

ACC Training Group, cont. (Variables 18 through 34)

(1)	(18)	(19)	(20)	(21)	(22)	(23)	(29)	(30)	(31)	(32)	(33)	(34)
206	10	10		70	100	100	78	100	00	78	00	100
207	40	100		50	70	90	11	50	00	33	70	60
219	00	100		30	100	50	100	100	100	78	70	80
222	20	30		30	90	100						
304	00	80		40	100	100	44	50	17	11	40	30
307	20	60		30	30	50	00	8	00	11	00	20
308	20	70		40	100	100	100	100	100	100	60	100
515	00	20		60	80	60						
518	10	20		60	80	90	22	33	33	67	10	90
519	40	50		50	70	60	100	83	100	67	70	70
523	40	40		50	30	90	100	92	100	89	40	70

Control Group, cont. (Variables 18 through 34)

(1)	(18)	(19)	(20)	(21)	(22)	(23)	(29)	(30)	(31)	(32)	(33)	(34)
108	00	80		50	70		100	100	100	67	90	100
119	40	20		30	40	30	11	33	00	11	50	40
126	00	00		30	30		11	25	00	33	00	30
127	00	20		50	60	40	100	100	100	67	50	50
129	80	80	100	60	60		100	100	100	00	70	60
214	40	100		30	80	30	100	92	100	89	50	60
218	00	60		20	40	50						
223	90	100		50	80							
225	10	30	70	50	60							
226	10	100		50	40		100	100	100	56	80	70
309	40	40		50	60	50	33	17	00	22	20	70
313	30	100	60	100	100		100	92	100	100	90	100
318	30	100		20	80							
512	90	90		30	50							
524	20	00		30	30	10						
525	50	30	40	40	40							

Experiment IVb

DQ Training Group

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(12)	(13)	(15)	(16)	(17)
412	M	15.84	8.55	54	100	100	100	83	100	100	100	55	44	
423	M	13.67	7.51	55	88	100	100	58	100	100	100	77	00	
425	M	14.00	7.70	55	22	100	100	25	91	00	100	100	88	
427	M	14.43	8.22	57	11	100	100	16	66	00	100	33	77	
472	F	8.09	3.80	47	100	88	100	66	75	50	100	44	11	
473	F	18.43	8.10	44	77	100	100	58	100	100	100	66	77	
475	F	17.84	10.34	58	11	100	100	50	83	00	100	77	100	
486	M	18.25	9.30	51	22	100	100	33	66	00	16	22	44	

O and C Training Group

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(12)	(13)	(15)	(16)	(17)
417	F	15.00	8.25	55	22	88		33	75	83	100	55	66	100
436	M	10.00	5.60	56	11	00		33	8	00	00	11	88	77
437	M	10.67	5.54	52	00	11		91	33	00	00	66	100	88
469	F	16.34	9.15	56	66	100		100	91	100	100	44	88	88
478	F	16.25	8.45	52	11	77		25	75	00	100	66	66	100
480	M	17.17	6.52	38	22	44		50	50	100	16	55	100	100
490	M	17.67	9.89	56	22	100		50	66	83	100	44	66	88

ACC Training Group

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(12)	(13)	(15)	(16)	(17)
420	M	16.59	7.79	47	55	88		66	75	00	00	55	33	
422	M	17.34	7.97	46	55	100		41	25	00	66	55	55	
431	M	10.67	6.50	61	55	66		100	91	00	00	55	66	
432	M	12.00	6.00	50	88	88		66	83	100	50	66	100	
474	F				11	22		25	50	00	00	55	11	
485	M	18.00	10.44	58	55	100		100	100	100	100	77	33	
487	M	18.00	8.64	48	33	44		66	91	16	00	33	11	

Experiment IVb, cont.

Control Group

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(12)	(13)	(15)	(16)	(17)
413	M	13.67	6.42	47	00	00	22	16	16	00	00	33	44	
414	F	14.59	6.85	47	100	100		58	75	100	100	33	44	55
421	M	13.17	5.79	44	55	100		25	83	00	33	22	33	
482	M	17.34	7.62	44	66	100		75	91	00	100	55	22	
488	M	17.17	8.58	50	100	100	100	83	91	83	100	88	77	
492	M	14.92	7.16	48	33	66		58	91	00	100	22	88	55

DQ Training Group, cont. (Variables 18 through 34)

(1)	(18)	(19)	(20)	(21)	(22)	(23)	(29)	(30)	(31)	(32)	(33)	(34)
412	00	10		30	20		100	83	100	44	10	40
423	10	40		30	20		100	58	100	44	10	20
425	50	00		20	20		100	92	100	78	40	20
427	30	70		50	50							
472	00	10		50	40							
473	00	70		60	40							
475	100	60		40	30							
486	20	30		70	90							

O and C Training Group, cont. (Variables 18 through 34)

417	50	50	60	50	40		100	25	100	22	40	40
436	20	100	80	40	40		11	33	00	67	70	40
437	20	60	80	50	40		44	58	17	100	20	60
469	30	70	90	50	60							
478	40	70	80	40	80		56	58	00	89	50	60
480	10	70	70	30	50		100	83	100	56	50	50
490	10	40	70	30	40							

Experiment IVb, cont.

ACC Training Group, cont. (Variables 18 through 34)

(1)	(18)	(19)	(20)	(21)	(22)	(23)	(29)	(30)	(31)	(32)	(33)	(34)
420	10	30		50	100	100	44	100	83	56	10	90
422	50	30		70	70	100	00	8	00	11	10	70
431	20	30		40	40	90	100	100	100	56	30	70
432	20	40		40	90	100	100	83	100	33	10	90
474	20	00		40	80	70	11	42	00	00	00	40
485	30	60		20	100	90						
487	80	60		50	90	80						

Control Group, cont. (Variables 18 through 34)

413	30	20		20	20		00	25	00	33	00	10
414	30	30	50	40	50		100	67	100	11	20	60
421	20	40		30	20	20	100	83	17	33	60	30
482	00	10		40	40	30	100	58	100	56	00	30
488	00	100		40	00		100	83	100	89	100	50
492	10	40	10	30	40		11	83	00	33	70	20

Experiment V

Experimental Group

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(9)	(10)	(12)	(13)	(15)	(16)	(18)	(19)	(21)	(22)
155	F	11.58	7.64	66	78	100	100	100	00	100	78	44	20	20	40	30
159	F	10.50	7.88	75	33	100	67	83	00	100	44	67	20	40	40	90
162	F	10.08	6.25	62	44	67	17	25	00	00	22	11	20	70	50	20
163	M	8.33	4.83	58	78	22	58	83	17	17	00	33	10	50	40	20
165	F	8.92	6.33	71	100		83		100		33	67	20	60	30	30
166	F	8.50	6.38	75	44	56	92	100	00	00	00	78	10	40	60	40
170	M	11.33	6.34	56	00	56	8	33	00	67	22	33	00	20	60	30
303	F	10.33	6.09	59	56	100	42	92	00	100	22	78	60	60	50	60
307	M	10.08	6.55	65	00	89	8	67	00	83	11	100	00	40	20	10
351	F	7.92	5.70	72	00	22	25	50	17	00	22	89	60	20	50	100
355	M	7.50			00	100	25	83	00	100	00	00	10	60	10	40
360	M	9.33	6.25	67	56	100	25	100	00	83	33	89	20	90	40	50
370	F	11.50	7.71	67	44	78	42	100	00	00	78	100	20	80	40	90
371	F	11.75	7.17	61	44	100	83	100	17	56	67	78	00	70	30	40
518	M	10.42	6.25	60	22	78	33	58	33	00	67	67	10	10	90	50
554	F	9.08	5.81	64	11	100	42	75	00	17	67	11	20	60	40	40
570	M	9.17	7.06	77	89		75		100		44	56	50	70	50	30
573	F	9.08	6.72	74	22	11	25	25	00	00	33	67	30	00	10	70
574	F	9.58	6.13	64	100	100	83	83	00	100	67	78	00	90	40	80

Control Group

126	M	8.42	5.39	64	11	11	25	33	00	00	33	44	00	30	30	40
150	M	8.92	5.88	66	11	44	25	33	00	00	11	00	50	10	40	50
154	M	10.33	6.40	62	100		92		100		11	22	50	30	50	40
160	M	10.83	7.03	65	44	100	33	83	00	100	78	67	30	30	40	20
161	F	12.08	6.65	55	89		92		100		56	89	20	30	30	40
164	F	8.83	5.65	64	33	11	00	33	00	00	33	22	10	50	100	30
172	F	10.25	5.95	58	22	11	83	92	00	00	44	33	00	50	40	30
207	M	11.08	7.20	65	11	100	50	92	00	33	33	44	70	70	60	60
251	M	10.25	7.18	70	22	00	17	25	00	00	00	33	20	10	70	70

Experiment V, cont.

Control Group, cont.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(9)	(10)	(12)	(13)	(15)	(16)	(18)	(19)	(21)	(22)
304	F	8.67	6.33	73	44	67	50	50	17	00	11	89	40	30	30	20
359	M	9.67	7.06	73	44	89	33	100	00	100	33	78	20	30	70	60
363	M	8.92	5.88	66	56	00	83	50	00	00	00	11	00	50	30	30
365	F	10.83	6.71	62	22	78	42	100	00	00	22	11	00	70	60	40
376	M	10.83	7.58	70	56	78	50	67	00	83	33	67	00	30	20	60
378	M	7.17	5.23	73	22	22	8	50	00	00	33	11	00	00	40	50
522	M	10.92			11	11	50	58	17	17	56	33	90	30	40	30
576	M	10.42	6.46	62	56	78	50	83	00	00	33	67	00	30	20	40
578	F	11.50	8.74	76	100		92		100		56	89	40	50	30	50
579	F	9.50	6.46	68	22	56	50	83	00	100	11	00	30	30	80	80

Appendix Y

Pilot Group Test: Conservation, Ordination, Cardination, and Classification

A group test to measure conservation, ordination, cardination, and classification was developed in order to simplify the testing of Ss. The administration of the individualized tests required two approximately one-half hour sessions for each S. It was believed that a group test could be used to administer the discontinuous quantity (DQ), correspondence (Corr), continuous quantity (CQ), ordination (O), cardination (C), and additive composition of classes (ACC) tests to all members of a class simultaneously. Consequently, items related to DQ, Corr, CQ, O, C, and ACC were selected for inclusion in the group test. An attempt was made to keep the items similar to those on the individualized tests, although this was difficult for the conservation tests. Part I consisted of a vocabulary test, similar to Appendix B, used to determine whether the children understood the key words used in Part II. The breakdown of items on Part II was as follows:

DQ - Questions 1, 2, 3, 4
Corr - Questions 5, 6, 7, 8
CQ - Questions 9, 10, 11, 12
O - Questions 13, 14, 15
C - Questions 16, 17, 18
ACC - Questions 19, 20, 21, 22, 23, 24, 25, 26, 27

The test was given to three classrooms by their teacher as a pilot study in order to determine ease of administration. The teachers were asked to comment on any difficulties they encountered. The children tested were from two kindergarten classes (n = 11 and n = 12) and one first grade class (n = 26). The mean chronological ages were 6.20 (SD = .25), 6.09 (SD = .30), and 6.97 (SD = .57) for the above groups respectively.

On Part I, the vocabulary portion, comments from two teachers indicated that the children had difficulty with Questions 9, 19, and 20. They felt these questions were confusing for the children. In general, however, the children performed well on Part I, and no further analyses were performed.

On Part II, however, all three teachers felt that parts were extremely difficult for the children. Two teachers felt that Question 10 on conservation was rather confusing. Moreover, all three teachers agreed that the questions on ordination and cardination (Questions 13 through 18) were too difficult and confusing. Finally, one teacher felt that the ACC questions (19-27) could be improved in form, since children lost track of where they were supposed to mark their responses.

In order to obtain a rough index of whether the items may have been appropriate, performance on each item on Part II was checked against the total score. The lowest and highest approximately 33 per cent of the children were designated as the Lower (L) and Upper (U) group with 17 children in each. An item analysis was carried, using the phi coefficient to determine whether the U group responded differently from the L group. The tables at the end of this appendix show the items on which the groups differed. Approximately 63 per cent of the items discriminated between the U and L groups. Questions 10, 15, 19, 22, 23, 26, and 27 were very difficult (only 20 per cent or less of the 49 children responded correctly) and did not discriminate between the U and L groups. Consequently, further pilot work is indicated.

Directions for Administering the
Number Readiness Test

PART I -- Vocabulary

Note to Teacher:

As you read the directions, stop and check to see that each child follows you. Use an empty test booklet and point to the right place. Walk about the children to make sure they are working on the right item. If a child is not working on the right item, help him but do not give any answers.

Make sure the children work alone and do not give answers aloud. This test is untimed so that each child will have time for each problem. If a child does not understand the instructions, they may be repeated. The children must not answer each item, but walk about to see that they are working on the right item.

Instructions to Children:

Open your book to the first page.

Look at the first row of pictures. Which is the picture of the gun? It is this one. (Show in an empty test book.) See how it is marked? It has a big X on it. That is how I want you to mark the right answers to the questions I will ask you.

For example, look at the next row. Mark the shoe by putting a big X on it like the X on the gun.

Did you mark this one? (Point to the shoe in the empty booklet. Walk around to make sure everyone got it right.)

1. Here is a picture of some ladders (show child by holding up an empty booklet). Mark the smallest ladder...mark the smallest ladder.

2. In the picture above (show in the empty booklet) you marked the smallest ladder. Now, in this picture (show child), mark the next smallest ladder... mark the next smallest ladder.

3. Mark the *biggest* ladder...mark the *biggest* ladder.

4. In the picture above you marked the biggest ladder. Now, in this picture, mark the *next biggest* ladder... mark the *next biggest* ladder.

5. Mark the *shortest* ladder...mark the *shortest* ladder.

6. Mark the *next shortest* ladder...mark the *next shortest* ladder.

7. Mark the *tallest* ladder...mark the *tallest* ladder.

8. Mark the *next tallest* ladder...mark the *next tallest* ladder.

9. See the flower by the ladder. Let us say that flower is in front of the row of ladders. Now find the ladder that is right *in front of* the one that the finger is pointing at.

   Mark the ladder right *in front of* the one that the finger is pointing at...mark the ladder right *in front of* the one that the finger is pointing at.

10. In this picture you will see two fingers pointing at two ladders.

    Mark the ladder *in between* the ones that the two fingers are pointing at...mark the ladder *in between* the ones that the two fingers are pointing at.

11. Mark only *ten* of the balls...mark only *ten* of the balls.

12. Mark the *first* ball in the row...mark the *first* ball in the row.

13. Mark the *last* ball in the row...mark the *last* ball in the row.

14. Mark the *second* ball in the row...mark the *second* ball in the row.

15. Mark the *third* ball in the row...mark the *third* ball in the row.

16. Mark the *seventh* ball in the row...mark the *seventh* ball in the row.

17. Mark the *ninth* ball in the row...mark the *ninth* ball in the row.

18. Mark the tenth ball in the row...mark the tenth ball in the row.

19. In each picture below you see two rows of balls.

    Mark the picture which shows that one row has more balls than the other...mark the picture which shows that one row has more balls than the other.

20. In each picture below you see two rows of balls.

    Mark the picture which shows two rows with the same number of balls...mark the picture which shows two rows with the same number of balls.

PART II -- Conservation, Ordination, Cardination, and Classification

Instructions to Children:

Open your book to the page with the star on top.

Mark the right answers with a big X just as you did before.

1. Which picture has more apples than the others? Mark an X on the picture that has more apples than the others.

2. Mark the picture that has more pencils than the others...mark the picture that has more pencils than the others.

3. Mark the necklace that has more beads in it than the others...mark the necklace that has more beads than the others.

4. Mark the glass that has more beads than the others... mark the glass that has more beads than the others.

5. Mark the picture that shows a baseball for each bat... mark the picture that shows a baseball for each bat.

6. Each of the pictures shows a row of girls and a row of boys.

   Mark an X on the picture that has the same number of boys and girls...mark the picture that has the same number of boys and girls.

7. Each of the pictures has two rows of dots. Which picture shows the two rows with the same number of dots? Mark an X on the picture that shows the two rows with the same number of dots.

8. Mark the picture that has the same number of shoes and stockings...mark the picture that has the same number of shoes and stockings.

9. Which picture has more water in it than the others? Mark an X on the picture that has more water in it than the others.

10. Mark the window that has more glass in it than the others...mark the window that has more glass in it than the others.

11. Mark the glass that has more water than the others... mark the glass that has more water than the others.

12. Mark the picture that shows more chalk than the others...the picture that shows more chalk than the others.

13. See the stairway in the first picture--each step goes up (demonstrate in a test booklet). The first step is marked 1, the second step is marked 2, the third step is marked 3, and so on up to the eighth step which is marked 8. The steps are marked in such a way because each step goes up and is the next biggest step (demonstrate).

    The second picture (point) is supposed to be a stairway too, but the steps are mixed up. See the first two steps, 1 and 2 have been marked for you.

    Now you must find Step 3 which goes up from Step 2 and is the next biggest step. Mark 3 on that step. Mark a number on each step to show which one must go next so that each step goes up and is the next biggest step--just like the stairway in the first picture.

    Finish marking the steps so that each step goes up and is the next biggest one--just like the stairway in the first picture. (Make sure child is working on the second picture. Wait until all finish.)

14. Now let's go on to the stairways at the middle of the page. Look at the first stairway. There is an X under one of the steps (point). Now, look at the second stairway (point). It does not have an X under any steps.

If you climbed up to the step with the X under it (point) on the first stairway and you climbed up the same number of steps on the second stairway (point), which step would you be on in the second stairway? Let me say that again for you. If you climbed up to the step with the X under it (point) on the first stairway and you climbed up the same number of steps on the second stairway (point), which step would you be on? Mark an X under that step on the second stairway. (Make sure the children are working on the second stairway. Wait until all finish.)

15. Now let's look at the next two stairways. The first stairway has an X under one step. The second stairway does not have an X under any steps, and the steps are mixed up so you'll have to try to put the steps back, in your head, like the first stairway.

If you climbed up to the step with the X under it (point) on the first stairway and you climbed up the same number of steps on the second stairway (point), which step would you be on?

Let me say that again for you. If you climbed up to the step with the X under it (point) on the first stairway, and you climbed up the same number of steps on the second stairway (point), which step would you be on? Mark an X under that step on the second stairway. (Make sure the children are working on the second stairway. Wait until all finish.)

16. Look at the first stairway. The steps in this stairway are special. They are made of blocks. The first step is made of one block (point). That is why there is the number 1 on it. The second step is made of two blocks (point to blocks) and that is why there is the number 2 on it. The third step is made of three blocks (point to blocks) and has the number 3 on it. The fourth block is made of four blocks (point) and has the number 4 on it, and so on, up to the eighth block which is made of eight blocks (point) and has the number 8 on it.

Now let's look at the second stairway. It's backwards, but it's exactly as big as the first stairway. You can cut the steps into blocks like the first stairway and get the same number of blocks for each step like the first stairway.

See the X on one step (point) of the second stairway? If we cut this step into blocks just as big as those in the first stairway, how many blocks would there be in it?

Let me say that for you again. If we cut the step marked X into blocks as big as those in the first stairway, how many blocks would there be in the step? Write the number of blocks under the X on the step. (See that the children work on the step with X. Wait until all finish.)

17. The first stairway in the next row is exactly the same as the ones we just talked about. It is made of blocks. The first step is made of one block (point) and that is why there is the number 1 on it. The second step is made of two blocks (point to blocks) and that is why there is the number 2 on it. The third block is made of three blocks (point to blocks) and has the number 3 on it. The fourth block is made of four blocks (point) and has the number 4 on it, and so on, up to the eighth block, which is made of eight blocks and has the number 8 on it.

    All right, let's look at the second stairway. The steps are all mixed up, but they are exactly as big as the steps in the first stairway. See the step with an X (point) in the second stairway? If we cut this step into blocks just like the first stairway, how many blocks would there be in the step? Write the number of blocks under the X on the step. (See that the children work on the step with X. Wait until all finish.)

18. The first stairway in the last row is like the ones we looked at before, except it's made of smaller blocks. The first step is made of one block (point). That's why it has the number 1 on it. The second step is made of two blocks (point to blocks), and that is why it has the number 2 on it. The third step is made of three blocks (point to blocks) and it has the number 3 on it. The fourth block is made of four blocks (point to blocks) and has the number 4 on it, and so on, up to the seventh block which is made of seven blocks and has the number 7 on it (point).

    All right, let's look at the second stairway. The steps are all mixed up, but they are exactly as big as the steps in the first stairway. See the step with the X (point) in the second stairway? If we cut this step into blocks just as big as those in the first stairway, how many blocks would there be in the step? Write the number of blocks under the X on the step. (See that the children work on the step with X. Wait until all finish.)

Now I'm going to ask you some questions about the picture at the top of the page. Under the picture notice there is a list of two words. The first word is "Yes" and the second is "No." If the answer to the question I ask is Yes, mark an X over the first word, "Yes." If the answer to the question is No, mark an X over the second word, "No."

19. For example, suppose I asked you the question, "Are all the children in the picture girls?" The answer to this question is "No." Mark an X over the "No." (Walk about and check that all children put an X over the "No." Correct all those who were wrong by putting an X over the "No.")

Now I'm going to ask you some questions. Mark "Yes" or "No" for the answer.

20. Are the boys children? Are the boys children?

21. Are the girls children? Are the girls children?

22. Are there more boys than children?

23. If we made a row out of all the boys in the picture and then made a row out of all the children in the picture, would the row of boys be longer than the row of children?

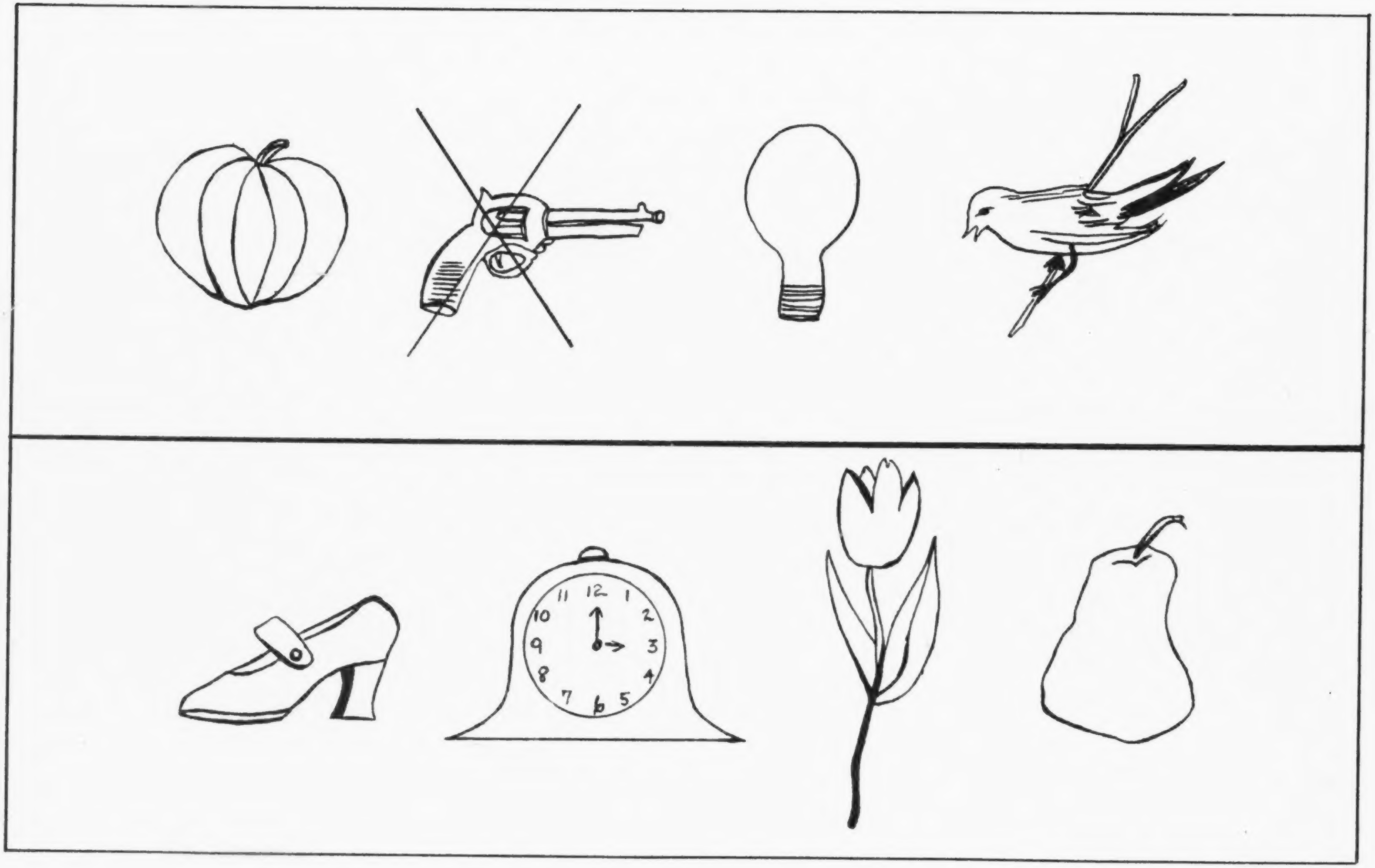
24. If all the boys went away to play marbles, would there be any children left?

25. If all the girls went away to school, would there be any children left?

26. If ten more girls were put in the picture, would there be more girls than children?

27. If we took all the girls out of the picture, would there be more boys than children?

Number Readiness Test



Part I Vocabulary

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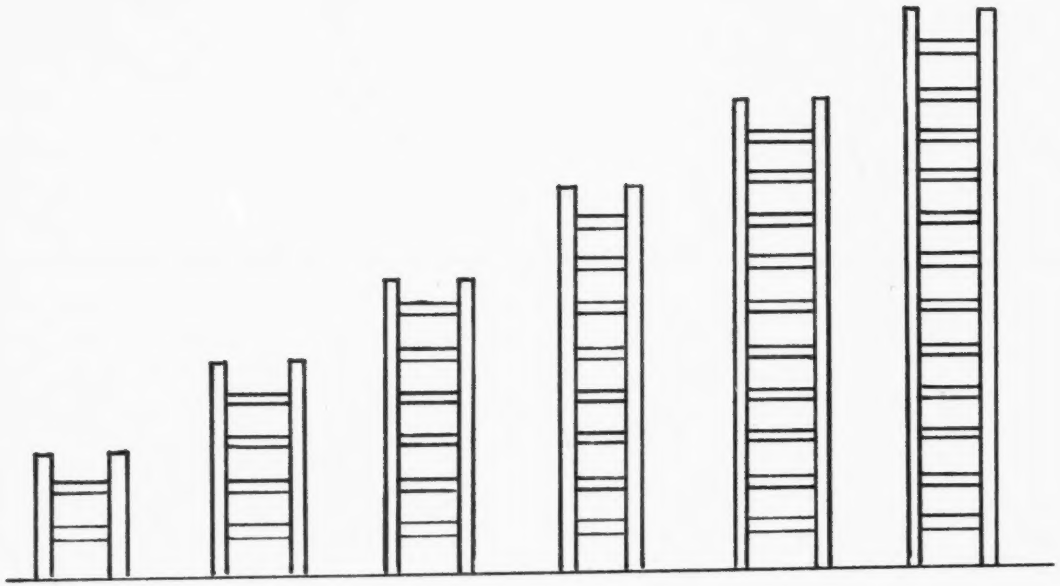

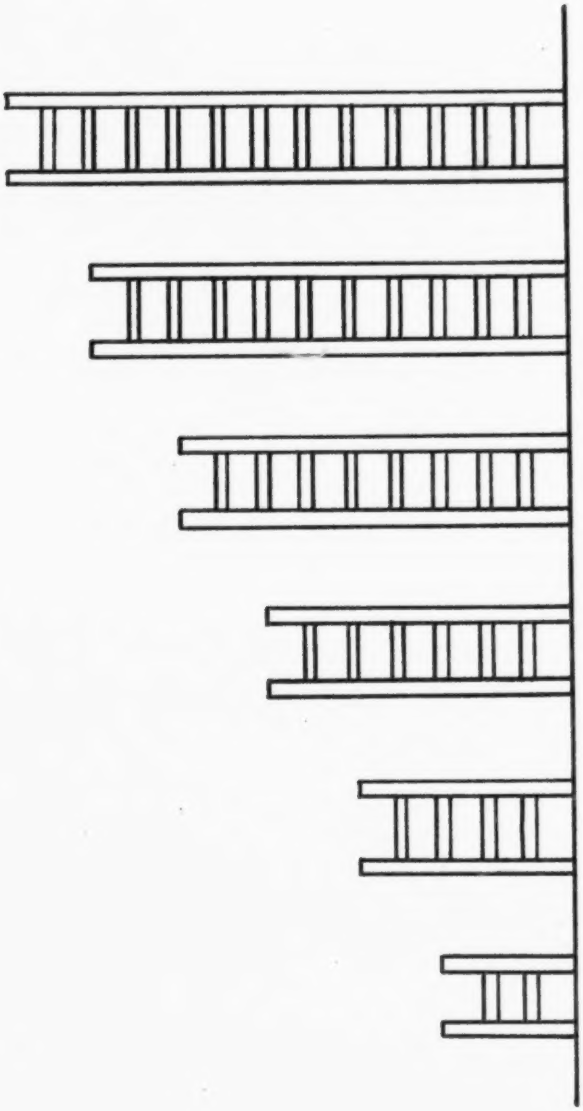

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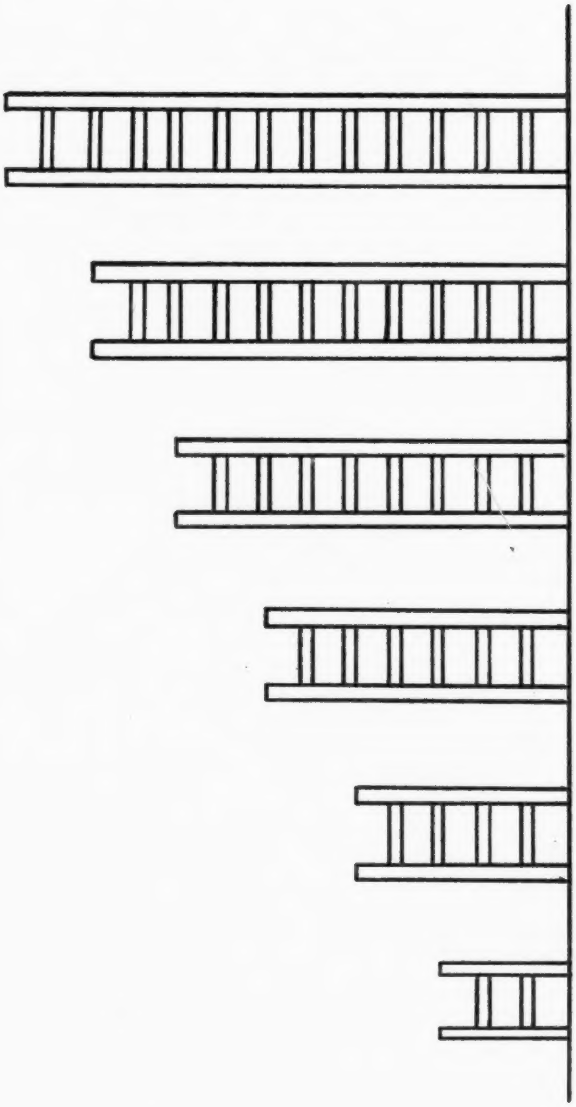

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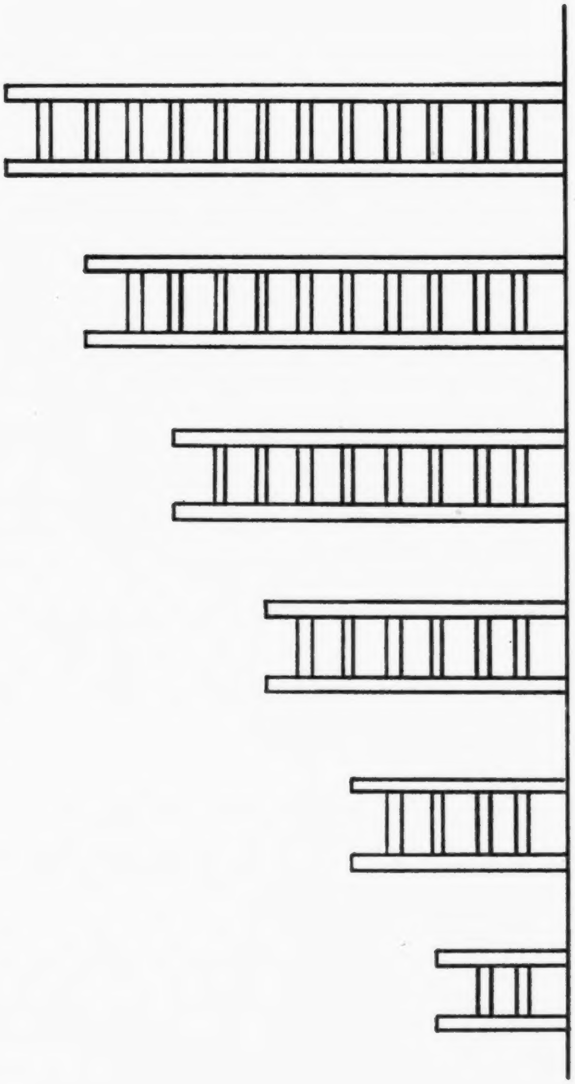

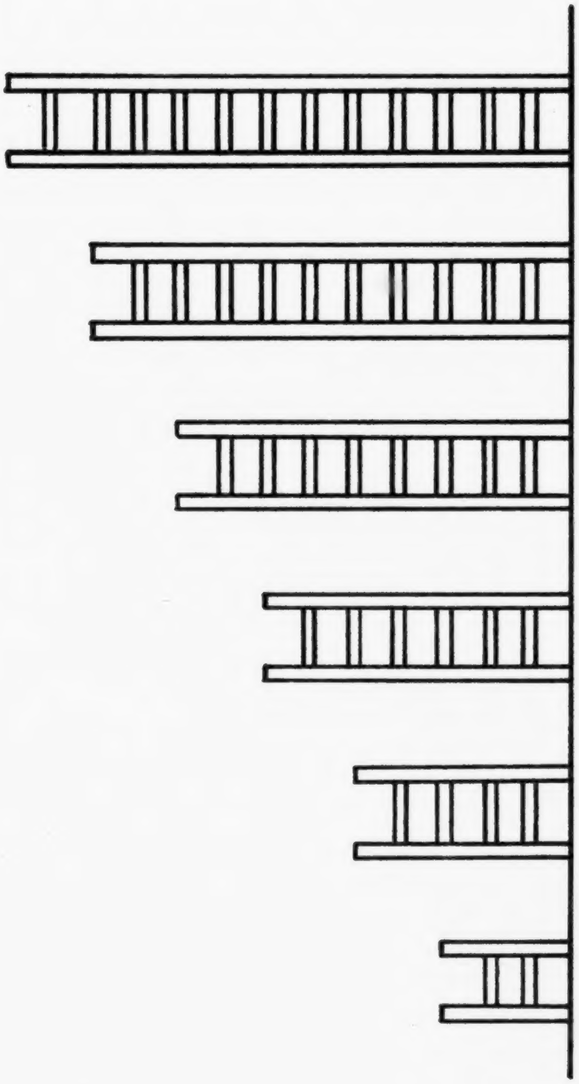

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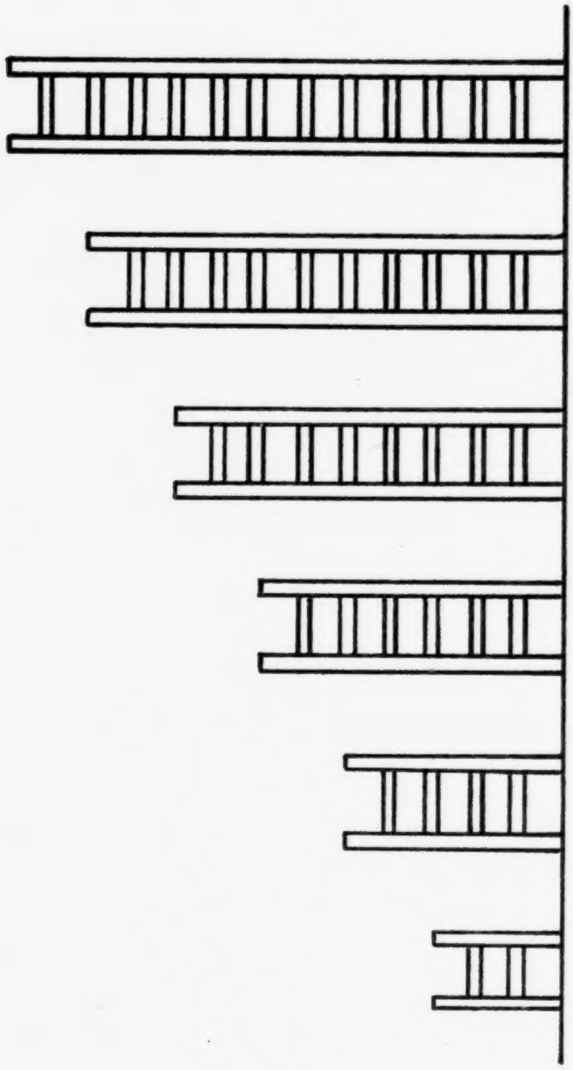

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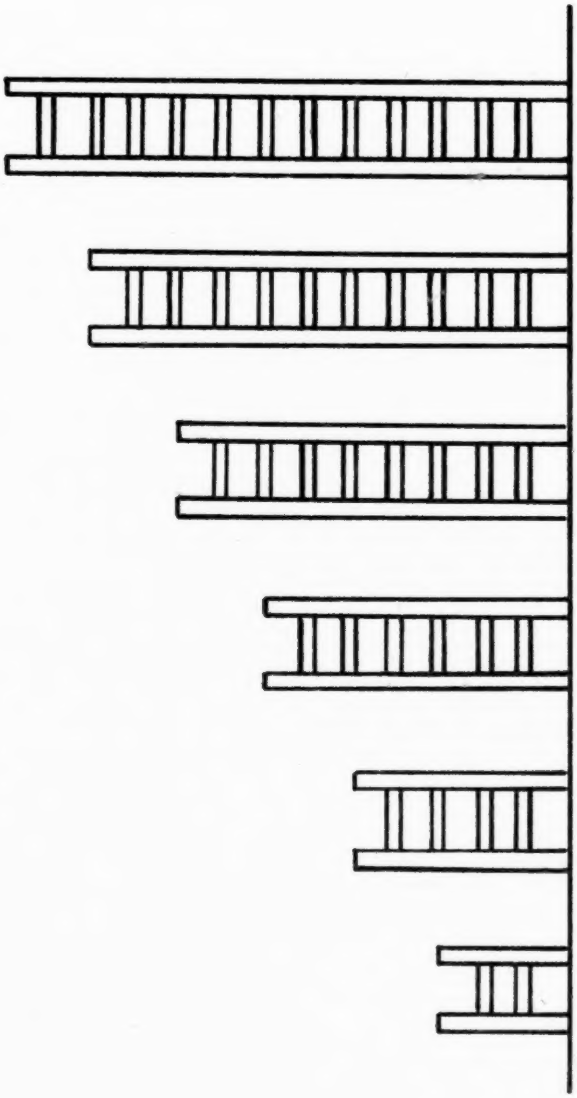

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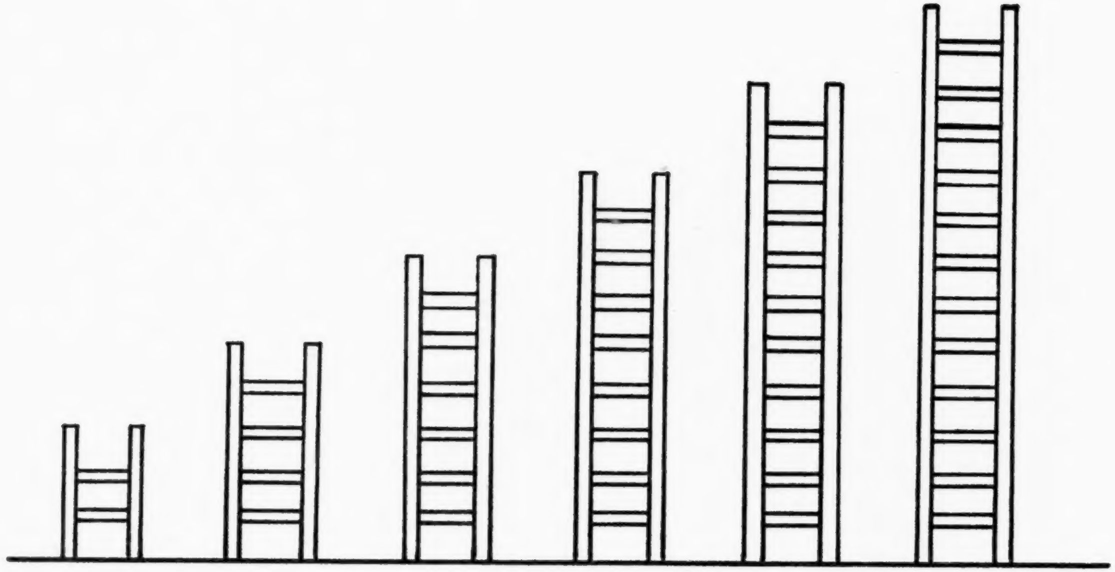

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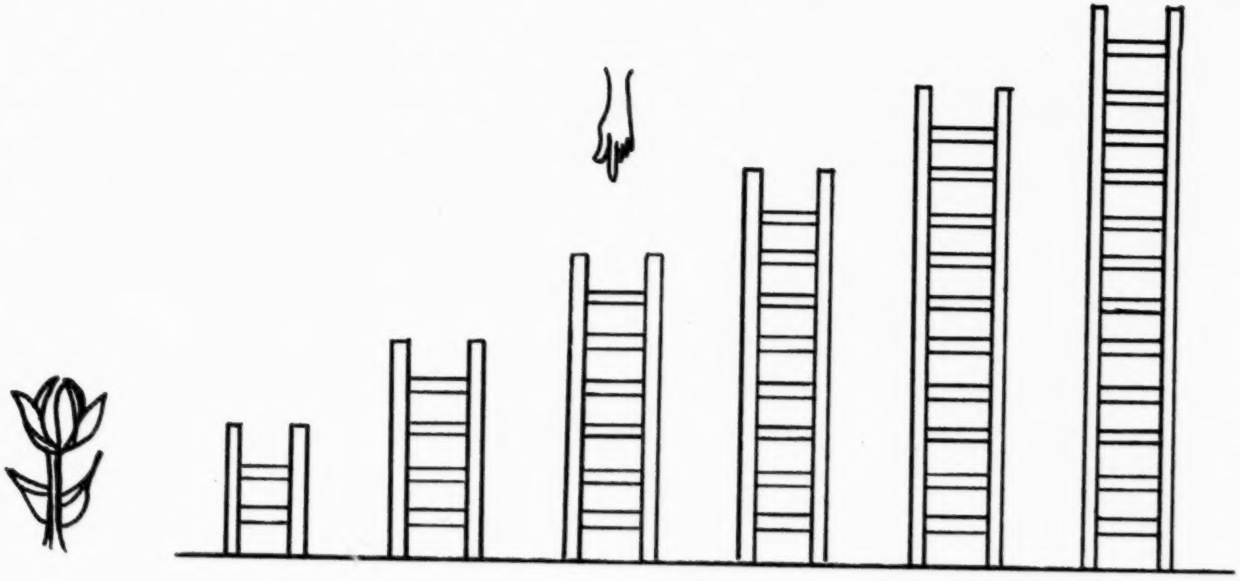

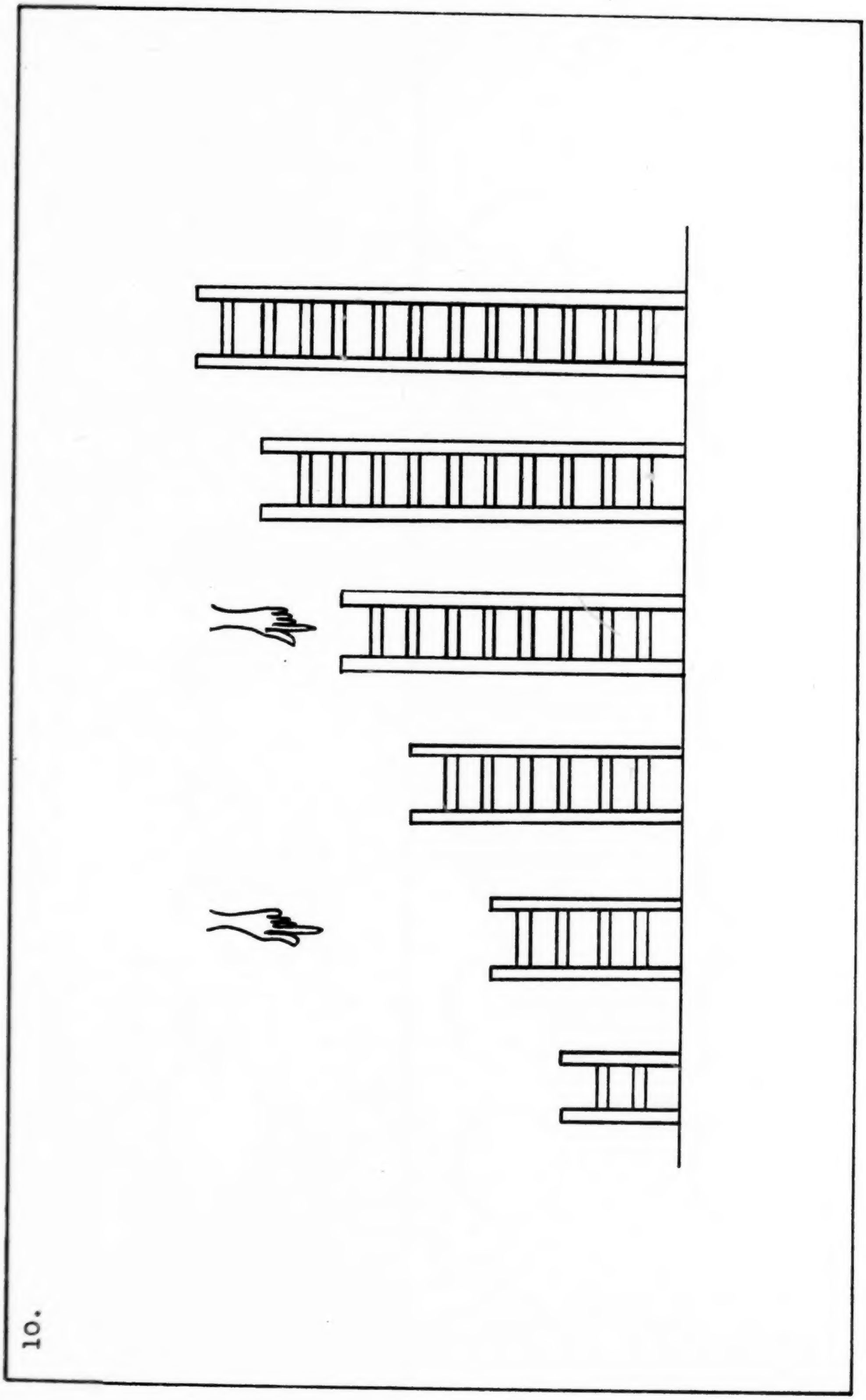

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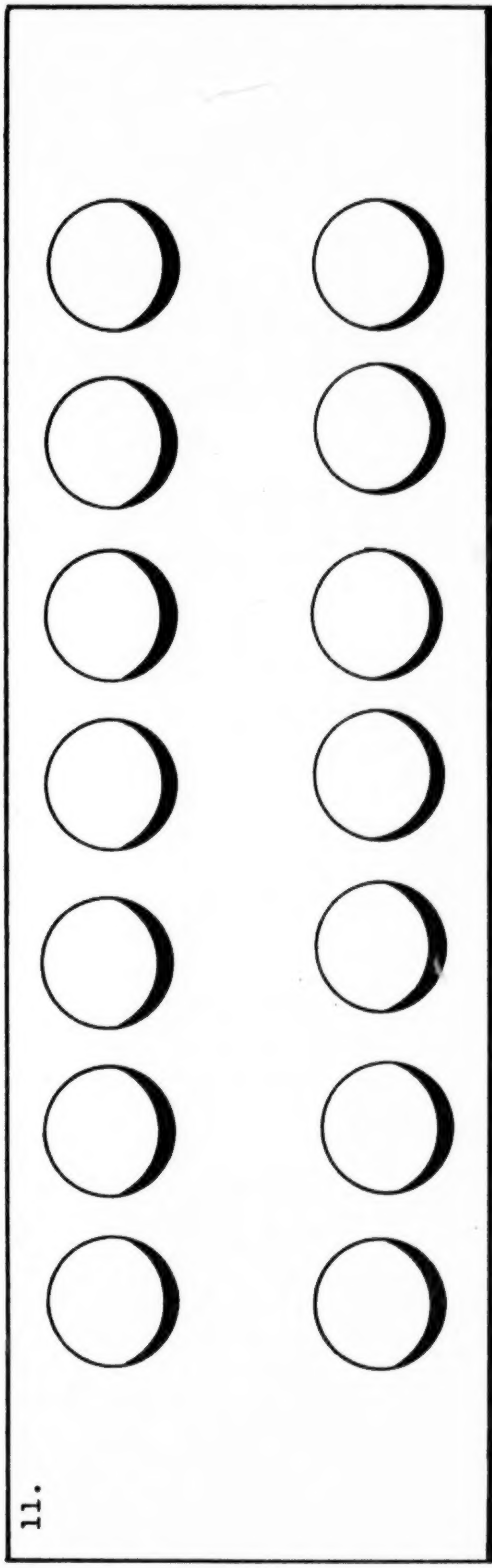

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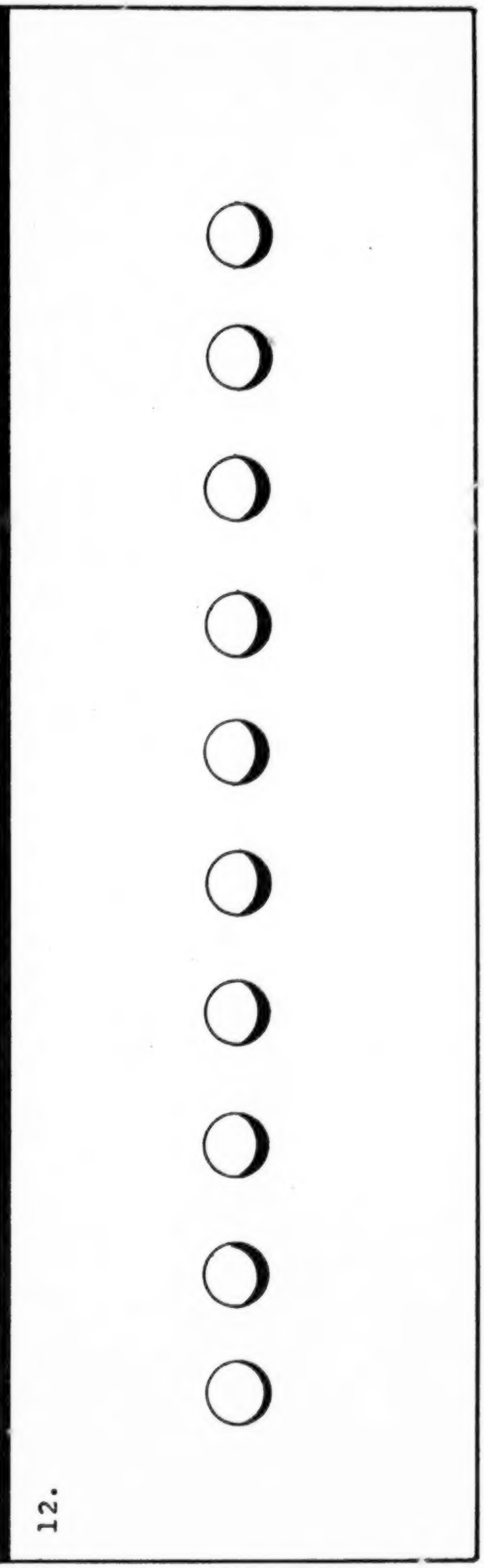

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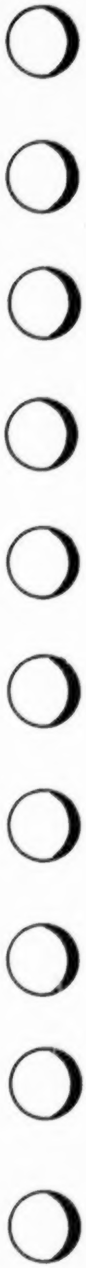

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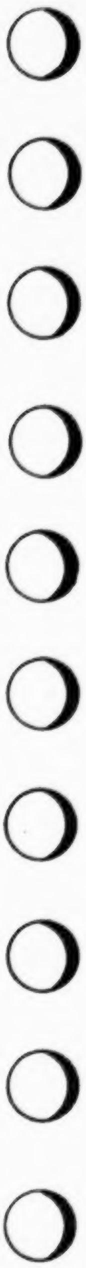

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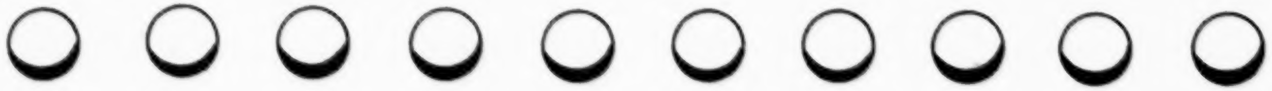

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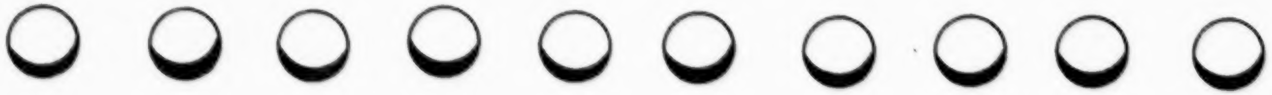

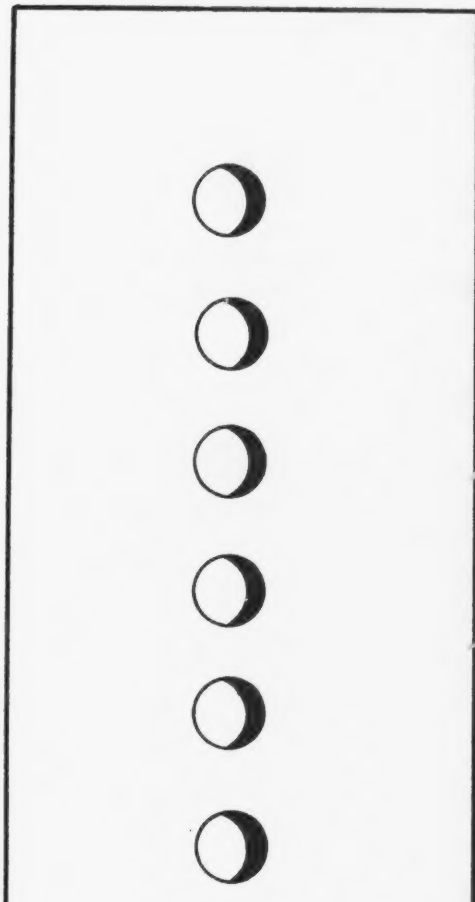

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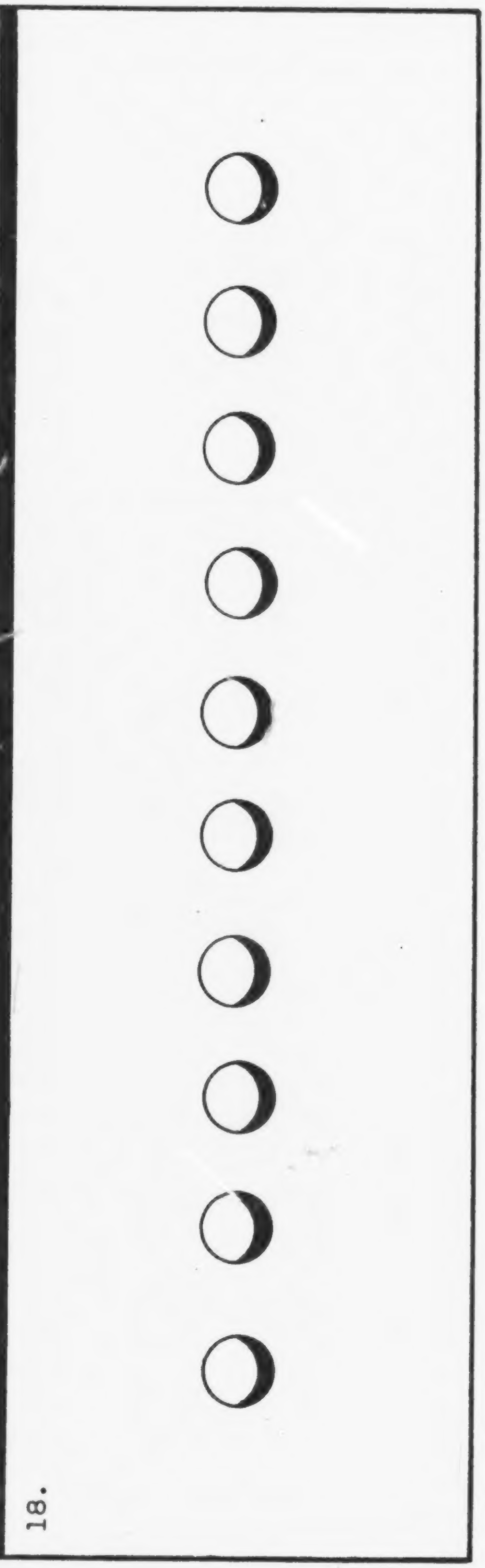

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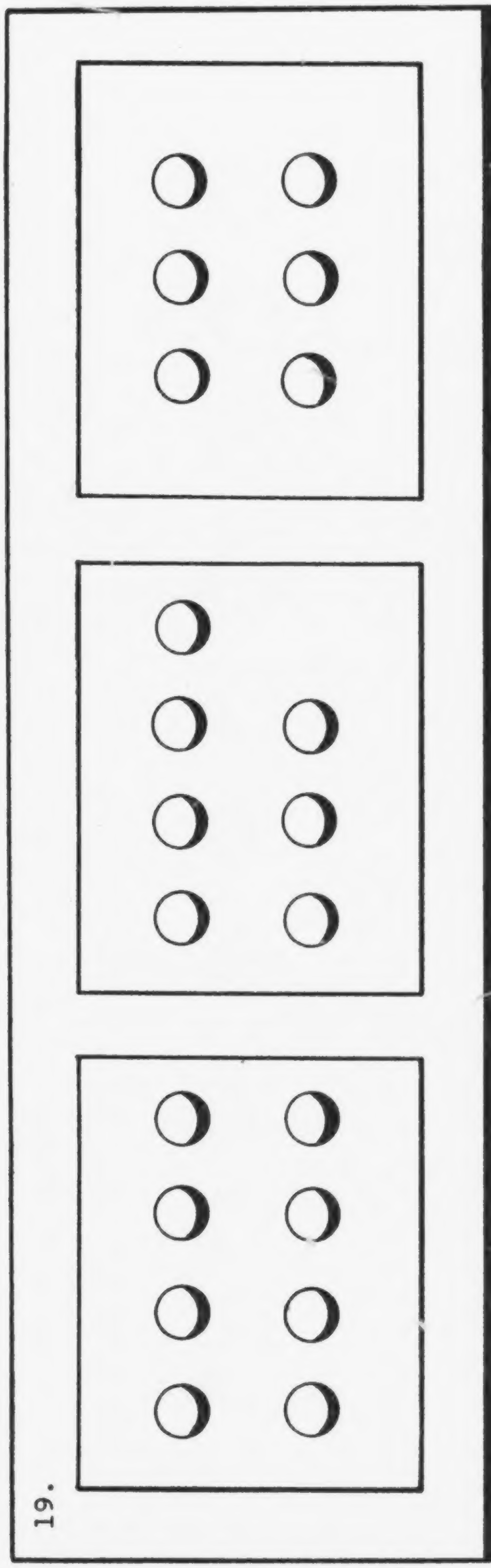

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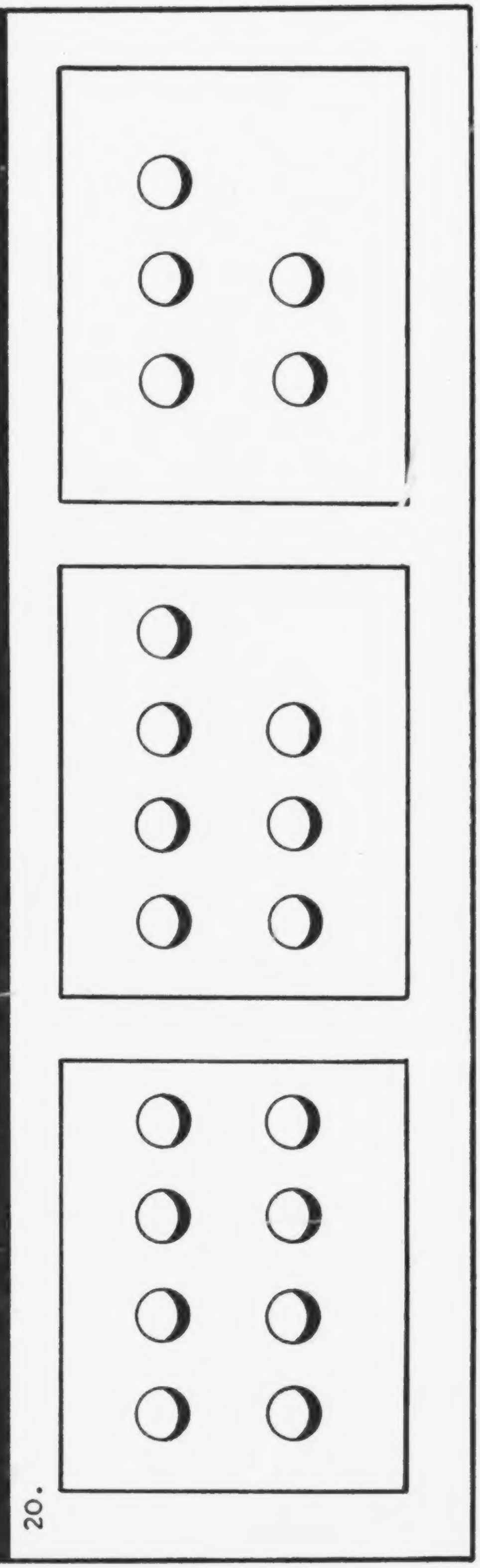

20.

Part II

Conservation, Ordination, Cardination, and Classification

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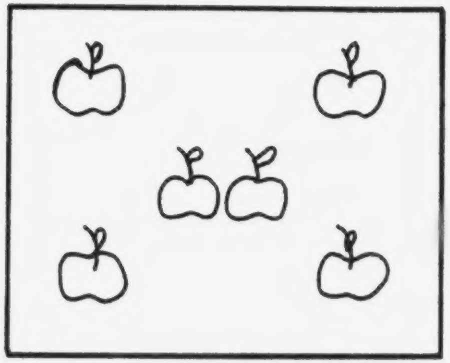
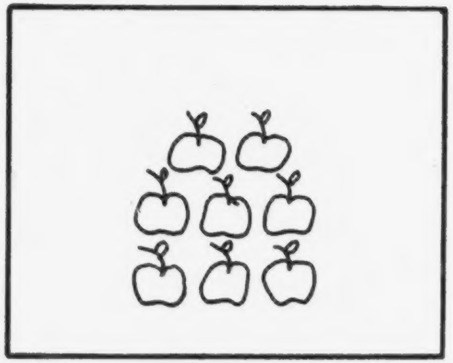
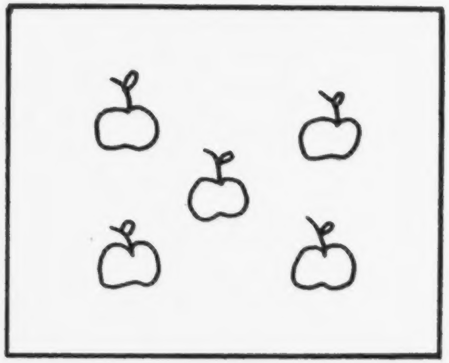
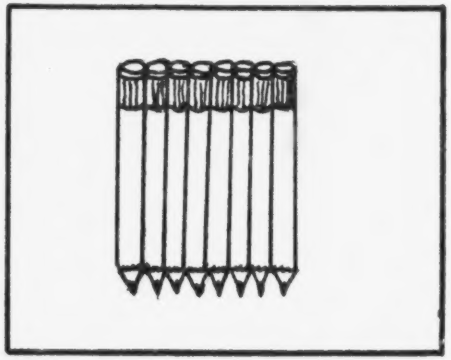
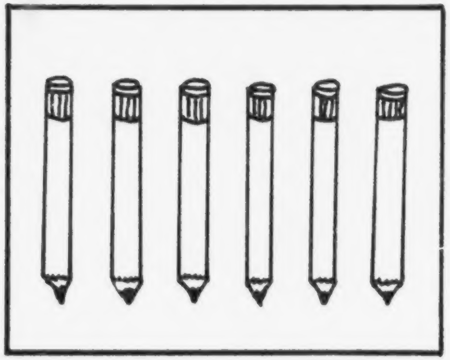


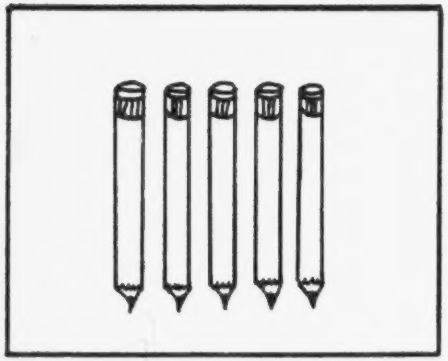


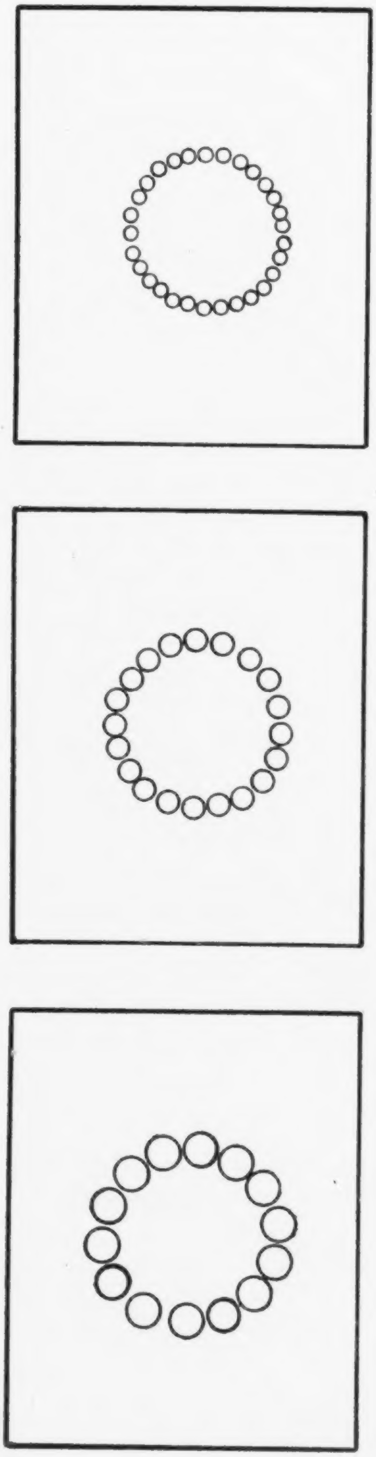


2.









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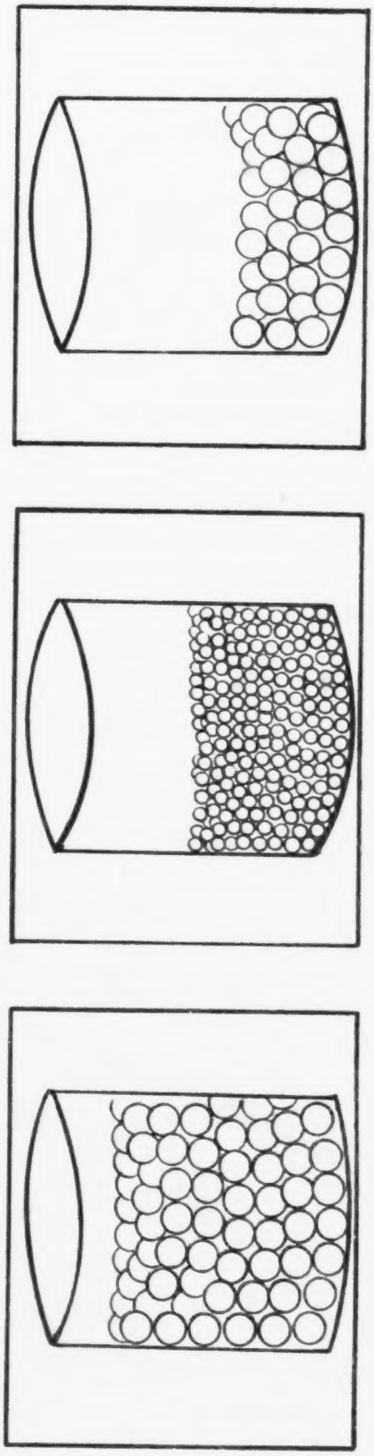

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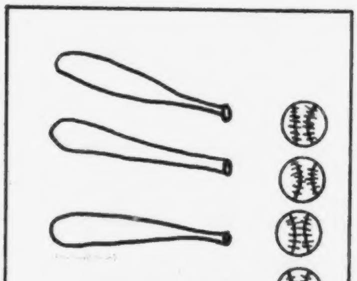

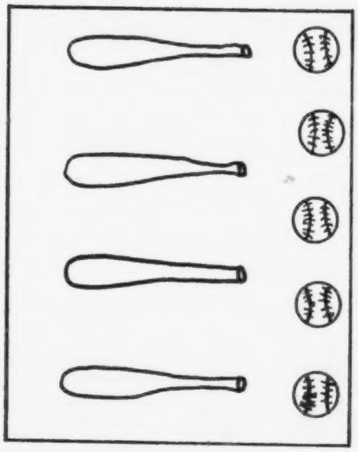

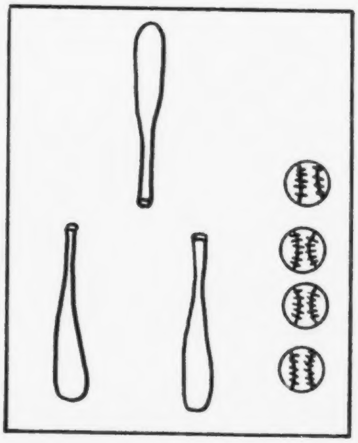

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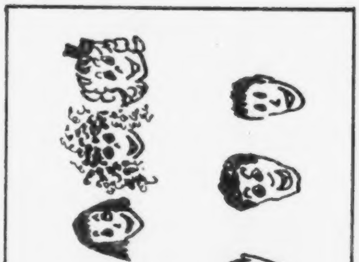

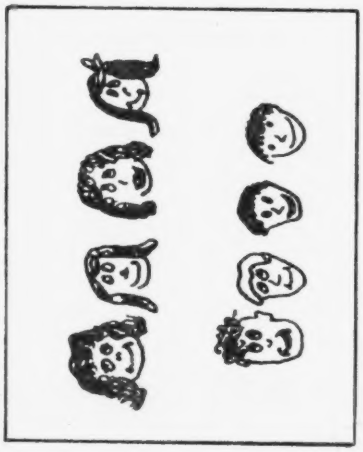

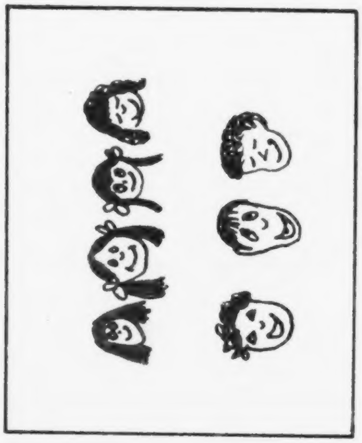

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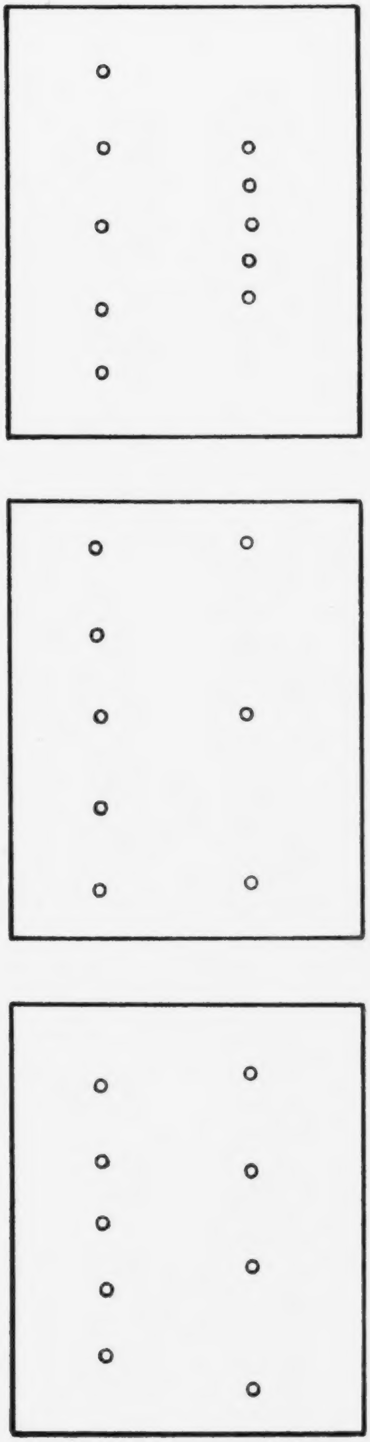

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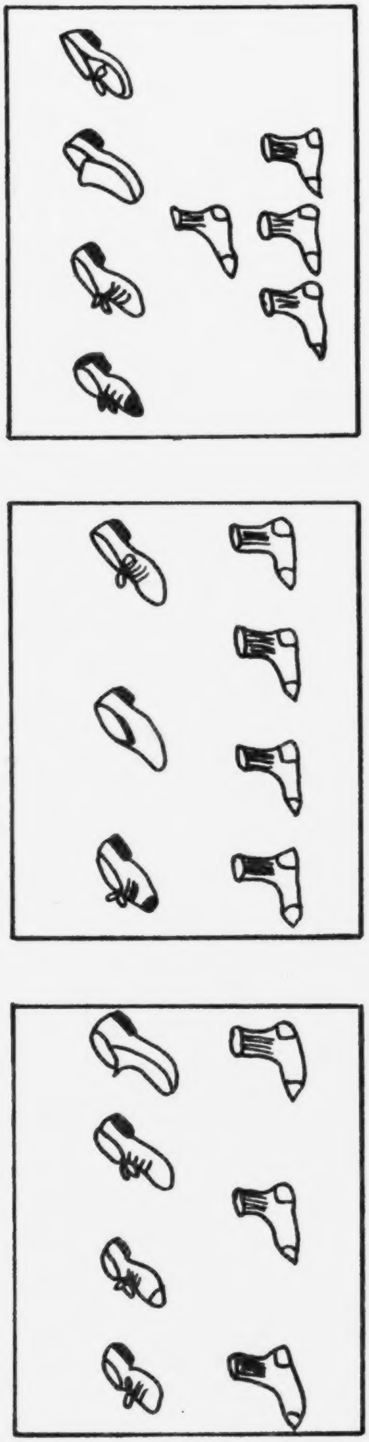

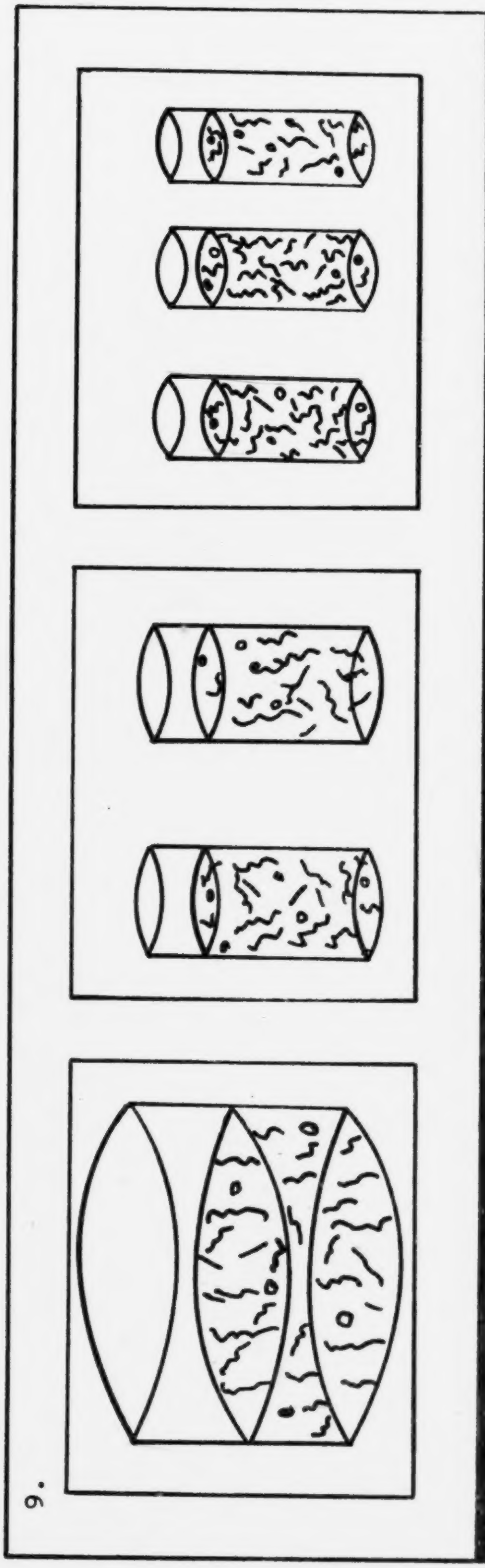

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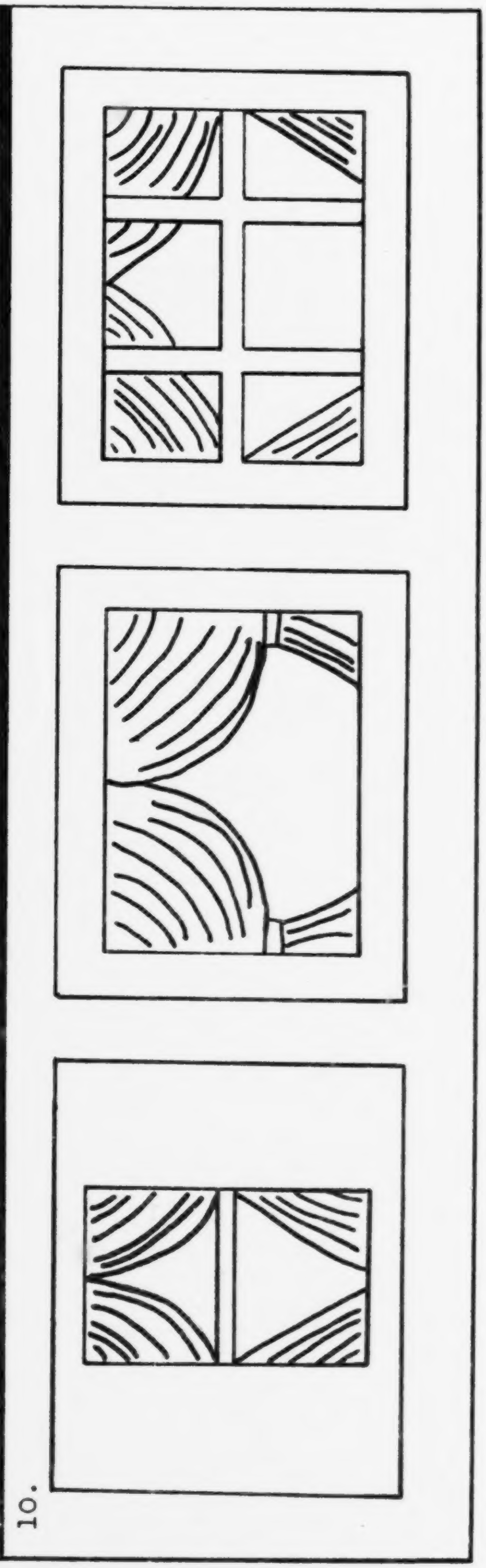

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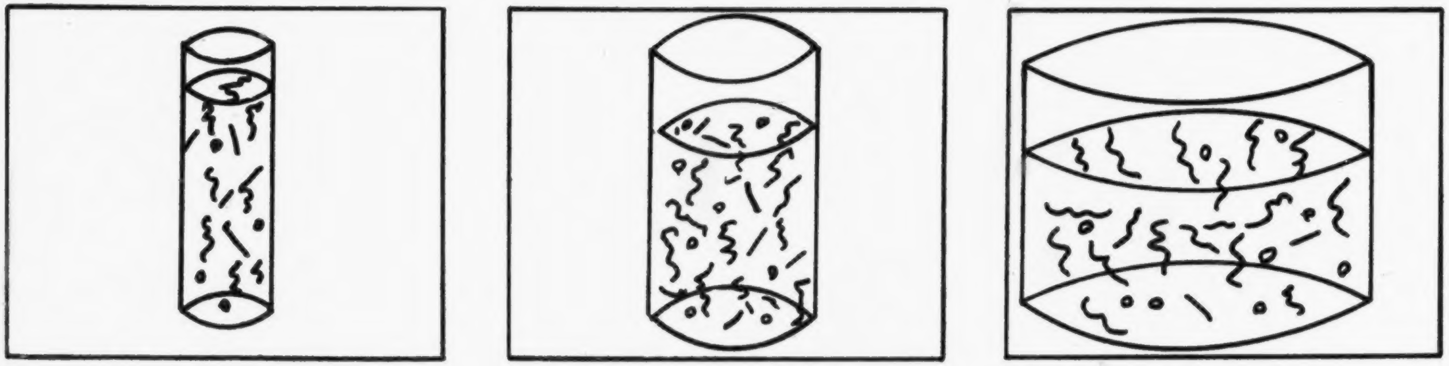

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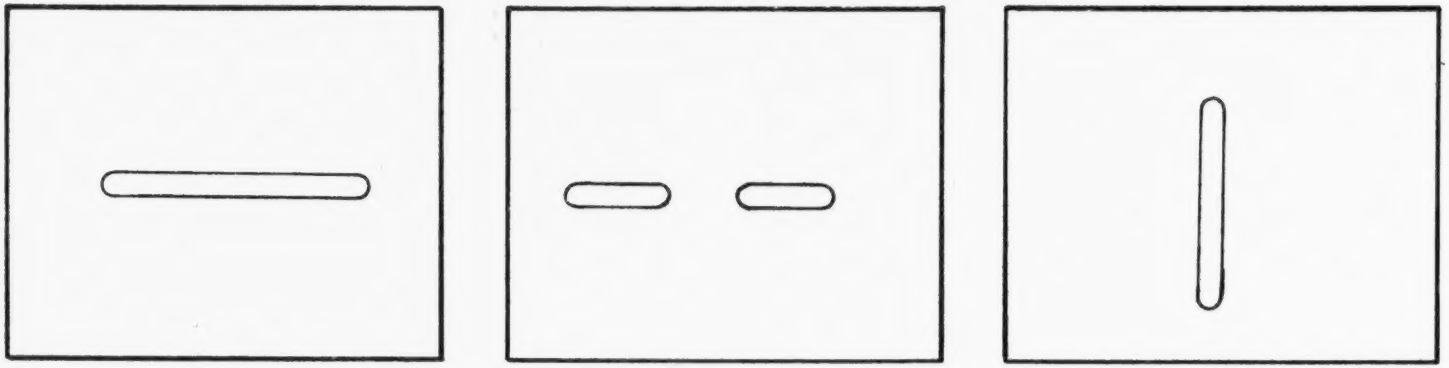

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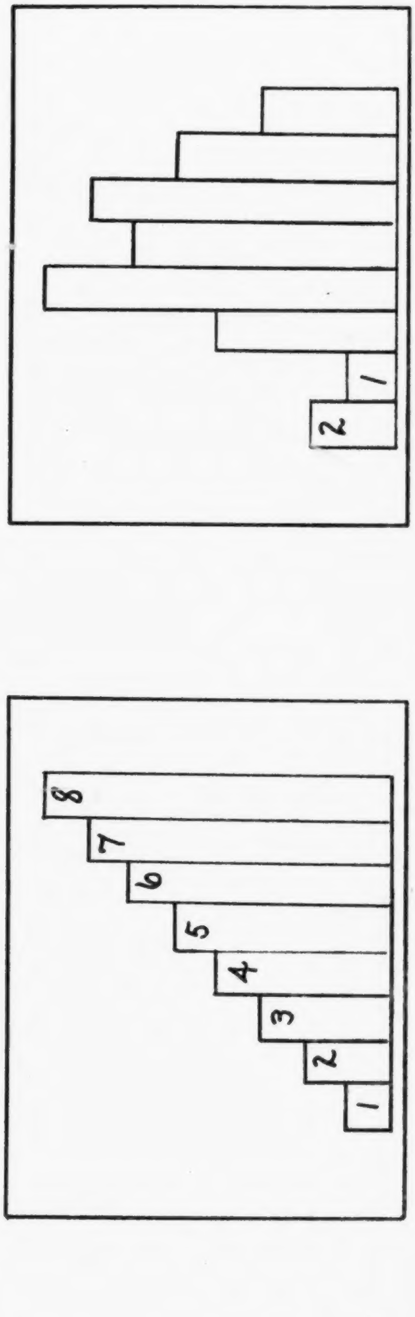
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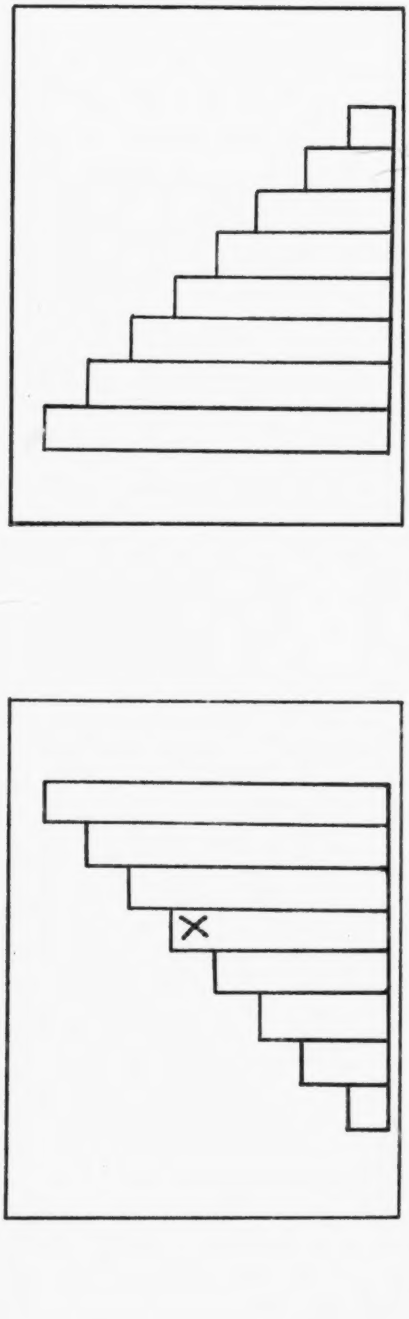

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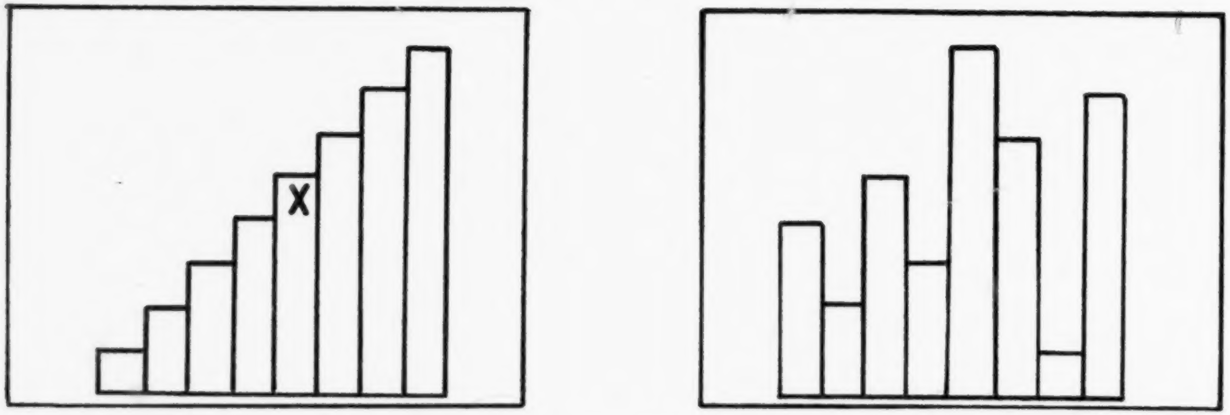

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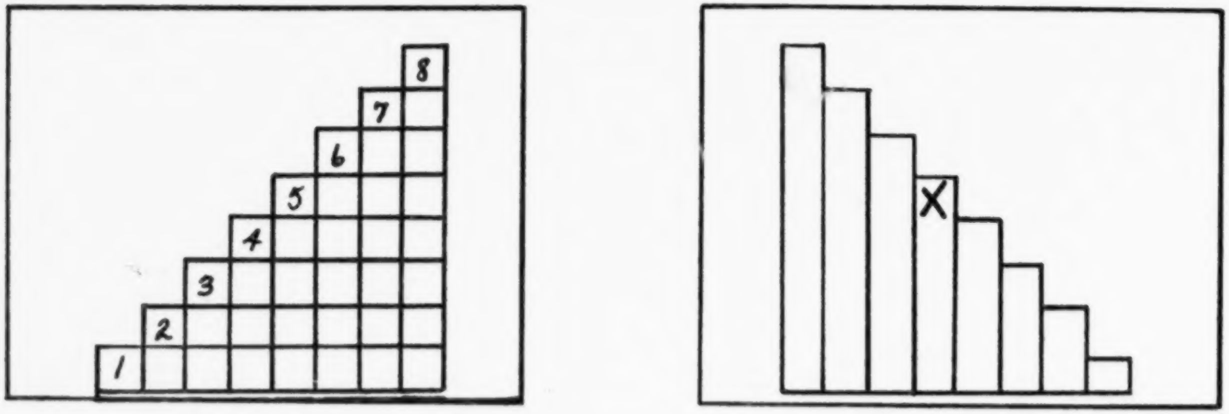

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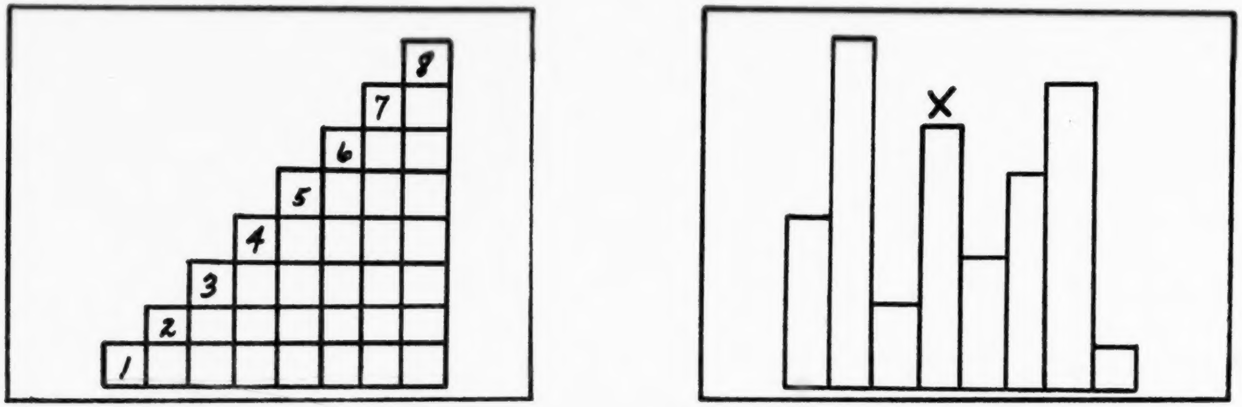

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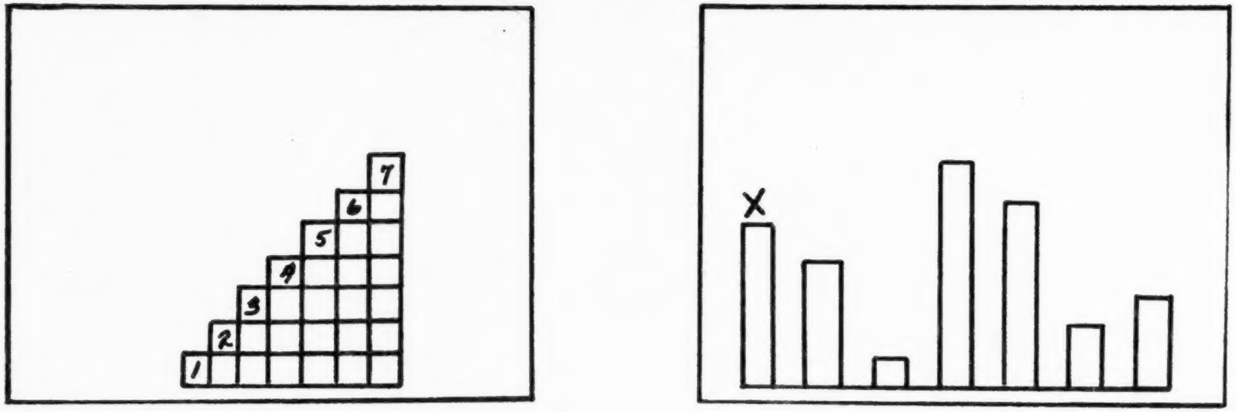

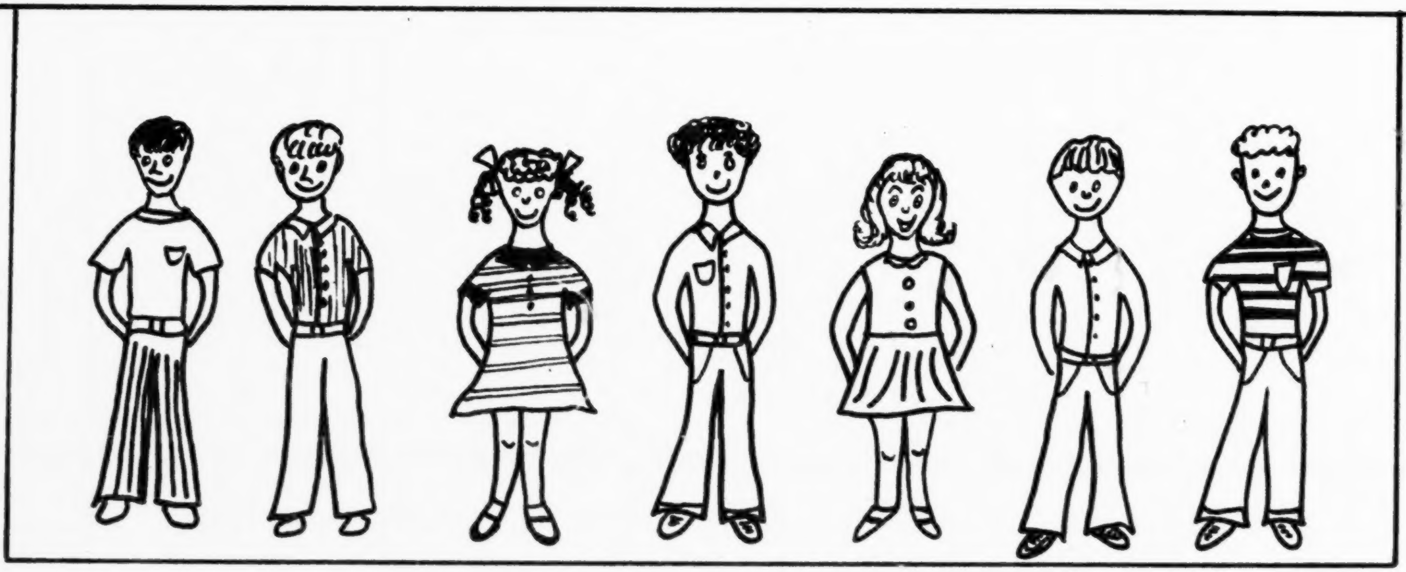

19. YES NO
20. YES NO
21. YES NO

22. YES NO
23. YES NO
24. YES NO

25. YES NO
26. YES NO
27. YES NO

Tables of Items on which the groups differed.

Item 1.*	P	F	Per Cent passing
U	17	0	.88
L	13	4	

Item 2.*	P	F	Per Cent passing
U	15	2	.69
L	9	8	

Item 3.*	P	F	Per Cent passing
U	13	4	.55
L	5	12	

Item 4.*	P	F	Per Cent passing
U	12	5	.51
L	6	11	

Item 5.	P	F	Per Cent passing
U	13	4	.71
L	10	7	

Item 6.*	P	F	Per Cent passing
U	11	6	.47
L	3	14	

Item 7.*	P	F	Per Cent passing
U	14	3	.49
L	1	16	

Item 8.*	P	F	Per Cent passing
U	14	3	.47
L	1	16	

Item 9.	P	F	Per Cent passing
U	14	3	.74
L	9	8	

Item 10.	P	F	Per Cent passing
U	4	13	.16
L	3	14	

Item 11.	P	F	Per Cent passing
U	11	6	.51
L	6	11	

Item 12.	P	F	Per Cent passing
U	14	3	.61
L	9	8	

Item 13.*	P	F	Per Cent passing
U	7	10	.20
L	1	16	

Item 14.*	P	F	Per Cent passing
U	14	3	.51
L	7	10	

Item 15.	P	F	Per Cent passing
U	4	13	.16
L	1	16	

Item 16.*	P	F	Per Cent passing
U	14	3	.43
L	3	14	

Item 17.*	P	F	Per Cent passing
U	10	7	.22
L	0	17	

Item 18.*	P	F	Per Cent passing
U	7	10	.16
L	1	16	

Item 19.*	P	F	Per Cent passing
U	7	10	.20
L	0	17	

Item 20.*	P	F	Per Cent passing
U	6	11	.25
L	1	16	

Item		P	F	Per Cent passing
21.*				
	U	14	3	.47
	L	3	14	

Item		P	F	Per Cent passing
22.				
	U	2	15	.082
	L	1	16	

Item		P	F	Per Cent passing
23.				
	U	2	15	.14
	L	2	15	

Item		P	F	Per Cent passing
24.*				
	U	10	7	.33
	L	1	16	

Item		P	F	Per Cent passing
25.*				
	U	7	10	.27
	L	1	16	

Item		P	F	Per Cent passing
26.				
	U	1	16	.020
	L	0	17	

Item		P	F	Per Cent passing
27.				
	U	2	15	.082
	L	1	16	

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* This item discriminates between the U and L groups at the .05 level.